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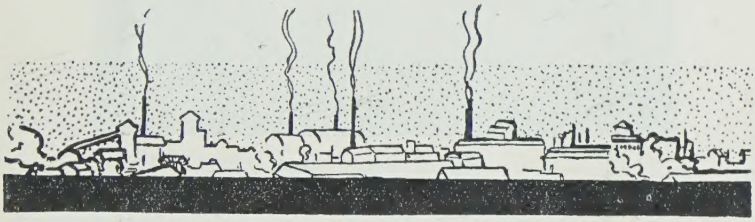

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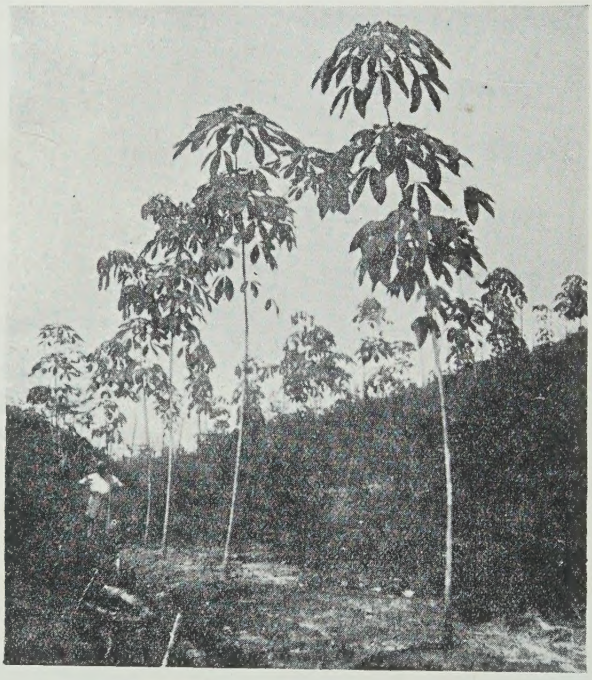

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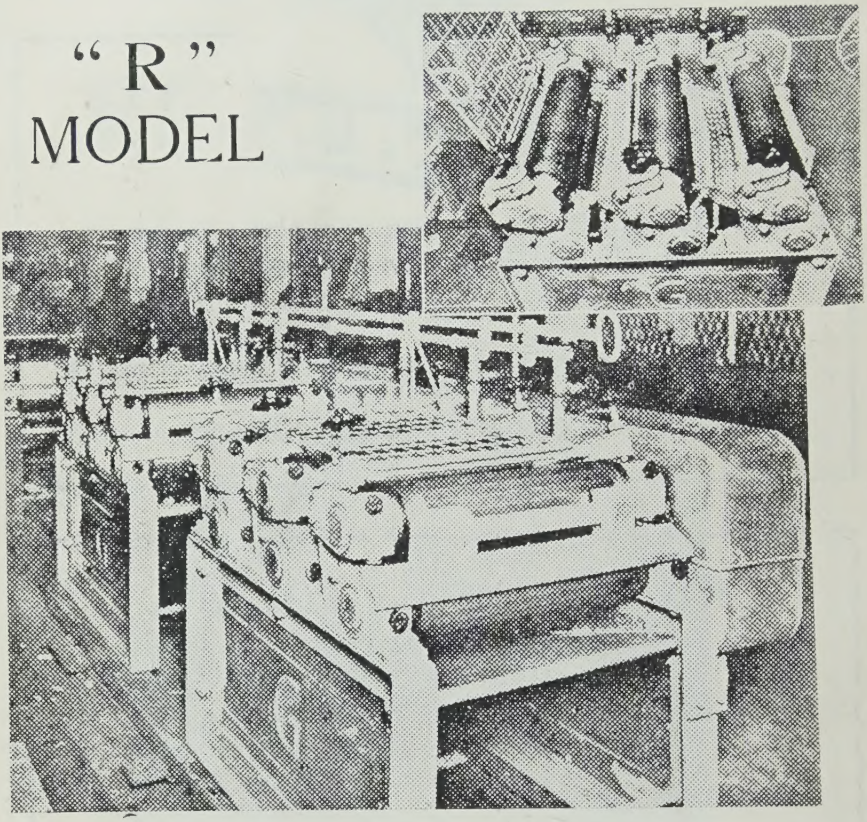

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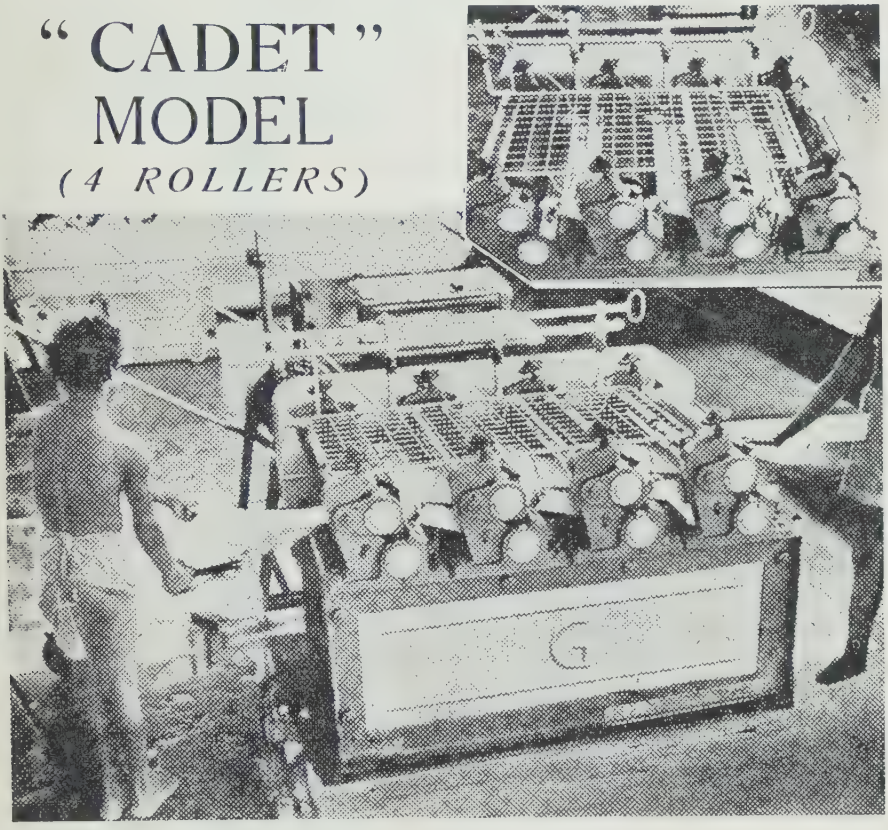

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No. 5 "The History and Description of Clones of Hevea Brasiliensis"
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by A. Sharples and A. R. Sanderson
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No. 4 "Summary of Meteorological Records, Soils Division"
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No. 5 "Variations in the Composition of Latex from Clone and Seedling Rubber"
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OF

THE RUBBER RESEARCH INSTITUTE OF MALAYA

CONTENTS

		Page
Obituary: Arnold Sharples	... ...	i
Editorial	... ...	1
Tapping of Budded Trees	*by C. E. T. Mann* ...	5
Experiments with Economic Tapping Systems Parts IV and V	*by C. C. T. Sharp* ...	24
The Treatment of the Pruned Surface of Large Stocks of Buddings of *Hevea brasiliensis*	*by C. C. T. Sharp* ...	39
Manuring Experiment on Young Rubber Trees—R.R.I. Experiment Station—Block 6	*by C. G. Akhurst* ...	46
"Diseases and Pests of the Rubber Tree"—A Review	... ...	65
"The Study of the Soil in the Field"—A Review	... ...	73
Choice of Clones for Replanted Areas: Notice	... ...	74
Samples forwarded to the Institute for Examination: Notice		76

THE RUBBER RESEARCH INSTITUTE OF MALAYA

The offices and laboratories are situate at the 3rd mile, Ampang Road, Kuala Lumpur. The postal address is P.O. Box No. 150, Kuala Lumpur, and the telephone is Ampang 47 and 48 (two lines). The telegraphic address is "Searching, Kuala Lumpur."

The laboratories of the Botanical, the Chemical, the Pathological and the Soils Divisions of the Institute are open, and the Divisional Officers are available, between the hours of 8.00 a.m. and 3.00 p.m. on all week-days except Saturdays, and from 8.00 a.m. to 12.30 p.m. on Saturdays. Intending visitors are, however, advised to make an appointment beforehand, to avoid the possibility of a fruitless visit owing to the absence of the officer concerned.

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OBITUARY

ARNOLD SHARPLES

1887—1937

The death of Arnold Sharples at the early age of 50 years, which occurred at St Annes-on-Sea, Lancashire, on 6th August, 1937, robs the science of plant pathology of one of its ablest servants.

Sharples' work in Malaya started in 1912, when he was appointed assistant mycologist in the Department of Agriculture. Apart from an interval of War Service from 1917—1919, —when he served with the Royal Engineers in England, Mesopotamia and India—, he worked as mycologist in the Department of Agriculture until 1931. In February of that year Sharples was seconded to the Rubber Research Institute as Head of the Pathological Division, and retained that position until his retirement in February 1934. From May 1932 to February 1933 he acted as Director during the absence of Col. Eaton on leave.

Having been closely associated with the study of disease problems in rubber plantations for nearly 20 years he brought

to the Institute a vigorous and well-matured research programme, initiating many of the more important investigations now being pursued, particularly those relating to root diseases and the standardisation of fungicides for the control of Mouldy Rot.

Though his position as Head of Division involved heavy administrative and advisory work, he found time to continue original research, his more important contributions being a bulletin (No. 3 in the Institute's series) on "The Root Disease Problem on Old Rubber Areas in Malaya," written in collaboration with the late Mr. A. R. Sanderson (November 1931); a paper entitled "Lightning Storms and their Significance in Relation to Diseases of (1) *Cocos nucifera* and (2) *Hevea brasiliensis*" published in the *Annals of Applied Biology* (February 1933); and another, in collaboration with Mr. H. Gunnery, on "Callus Formation in *Hibiscus Rosa-sinensis* and *Hevea brasiliensis*," published in the *Annals of Botany* (October 1933).

He will be still more remembered, however, for his masterly treatise on "The Diseases and Pests of the Rubber Tree" completed after retirement, and published last year by Macmillan and Co. An up-to-date work on this subject had long been needed, and no one was better qualified to undertake the task. The book is a mine of information for planter and research worker alike, and its publication formed a fitting climax to the author's long and successful career as a plant pathologist in this country. His friends little thought, when his book had such a wide-spread welcome on its appearance in 1936, that it would mark the end of his career, and that within a year it would also serve as his memorial.

Among his colleagues Sharples was known as a skilful investigator, with an unusual degree of administrative ability. A man of strong views and great tenacity of purpose he inspired confidence and respect in all with whom he came in contact. His manner was tempered by kindliness and a keen sense of humour, and in private life few could wish for a more genial and entertaining companion. His firm grasp of his subject and practical outlook on life made him highly popular with the planting community. His loss will be lamented by a wide circle of friends. His former colleagues at the Institute offer their sympathy to his widow and son in their bereavement.

JOURNAL

OF THE

RUBBER RESEARCH INSTITUTE OF MALAYA

VOL. 8 OCTOBER 1937 No. 1

EDITORIAL

This is the first number of the Institute's Journal to appear since the complete occupation of the Institute's new quarters in the first part of this year. The formal opening of the new buildings was carried out by His Excellency the Governor of the Straits Settlements and High Commissioner for the Malay States on the 19th May.

In the last issue, a description of the new buildings was promised, for a later issue of this *Journal*. Instead of this, however, it has been embodied in a separate illustrated booklet, which also deals briefly with the objects and scope of the Institute's work, and with its organisation, governance and financing. Copies of this booklet have already been sent to all those on the Institute's publications mailing list, together with the Annual Report for 1936.

TAPPING OF BUDDED TREES

One of the objections to budgrafting, which is still heard sometimes, is that budded trees are more difficult to tap than trees from seed. This objection is now heard less often than formerly, for as more and more areas of budded rubber come into commercial tapping, the difficulties are found to be less than was anticipated.

Mr. Mann's paper in this issue deals with this subject by considering the manner in which budded trees differ from seedlings. Generally speaking, in addition to differences in the relation of girth and bark-thickness to distance from the base of the tree, the bark of buddings differs in thickness from that of seedling trees; this difference results from the fact that the outer corky layer is thinner in buddings: the inner layer of latex-bearing tissue is as thick in buddings as it is in seedling trees. The non-latex-bearing corky layer makes up one-third to one-half of the total bark-thickness of seedling trees, but only about one-tenth of that

of most buddings. There is, moreover, no evidence of any deficiency in the bark-renewal of buddings of approved clones.

All that is needed to reap full advantage of the higher yielding-capacity of areas of buddings of such clones is that the method of tapping shall be adapted to the differences in thickness and character of the bark. Experience is amply proving that such adaption is easily within the powers of the ordinary estate labour force, and that the practical difficulties have been greatly exaggerated in the past. The overcoming of such difficulties as remain is a small price to pay for the proved higher yielding-capacity of buddings. Mr. Mann cites data to show that areas of buddings of approved clones, in tapping under normal estate conditions, are fulfilling the earlier promise of those clones and are reaching the maximum allowances given for budded rubber under Rubber Regulation rules for assessment.

The reputation of modern proved and approved clones is often liable to suffer unfairly owing to the shortcomings of areas of budded rubber now in commercial tapping, consisting of inferior and unproved clones which were used in the early days before these clones had been excluded in the process of developing the present approved list.

Economic Tapping Systems

Mr. Sharp gives in this issue an account of the results obtained in the third year of the experiment at Seventh Mile Estate, in which "A.B.C." tapping and certain "double-cut" systems, are compared with the standard alternate-daily system. The results for the first two years of this experiment were published in Volumes 5 and 6 of this *Journal*.

The experiment is planned to run for a period of five years (*i.e.* until May, 1938), and it would be unwise to attempt a premature consideration of the final conclusions likely to be drawn. It may be noted, however, that up to the end of the third year neither of the double-cut systems, Sunderland and Double-four, and particularly the former, seemed to possess enough advantages over the single-cut systems to outweigh the disadvantages that they possess in other respects; whilst the "A.B.C." systems had no clear-cut advantage over "A.D." tapping in respect of bark renewal.

Any tentative conclusions regarding the relative merits of "A.D." and "A.B.C." tapping, which the results of this experiment might seem to suggest, must take account of the fact that the trees in the area under experiment are exceptionally high yielders, and so their response to differences in systems of tapping may be very different from that of lower-yielding trees.

The Treatment of the "Snags" of Buddings on Large Stocks

In a previous paper in Vol. 5 of this *Journal*, Mr. Sharp showed that the standard asphalt-kerosene mixture, when applied to large budded stocks, retarded the growth of callus-tissue over the pruned surface. In a paper in this issue he describes a further experiment which has shown that, out of five different methods of treatment, the use of a covering of hessian cloth, together with the application of a mixture of cattle-dung and clay, gave the best results.

The callus-growth when clones B.D. 5 and P.B. 180 were used was slower than that with many other clones, so that these two clones are not to be recommended for the budding of large stocks. It was also found that postponement of pruning stocks until after wintering has little or no advantage over pruning before wintering.

The Manuring of Young Rubber Trees

The manuring experiment on Block 6 at the Institute's Experiment Station was commenced in 1928. It was designed to compare the effects of an organic manure (cattle-dung) with various inorganic fertilizers supplying nitrogen only, nitrogen and phosphate, phosphates and potash, and a "complete" fertilizer supplying nitrogen, phosphate and potash. Applications of these fertilizers were made in graded dressings, five during the first three years of growth and five during the next five years. In the earlier years the trees receiving cattle manure grew slightly better than the rest, but after the fifth year those receiving the complete (N.P.K.) inorganic manure caught up those receiving cattle manure, though the remainder remained slightly behind. The trees came into tapping at the beginning of 1935, and in this issue Mr. Akhurst gives the yield results for the first two years of tapping.

It is notable that, although the cattle-manure treatment shared the lead with the complete (N.P.K.) inorganic manure, so far as growth (girth) measurements were concerned, and was the first to take that lead, the yield of rubber from the cattle-dung-treated trees was no better than that from the other trees which it had surpassed in growth. The only treatment to give a significant increase in yield was the "complete" (N.P.K.) manure.

The soil in the lowland areas of the Experiment Station, where this experiment is situated, is of a poor sandy type, and it is noteworthy that potash appears to be an important factor in the superior effect obtained thereon with the complete inorganic manure. Whilst it is now becoming increasingly evident that phosphatic manuring, whether as an adjunct to nitrogen or not,

is a common requirement of many Malayan rubber soils, the need for potash, though probably less widespread, is probably also less uncommon than has hitherto been supposed.

Owing to differences in phosphate and potash content, as between the cattle-dung and the "complete" inorganic manure treatment, this experiment affords no conclusive evidence as to the relative merits of organic and inorganic nitrogenous manures.

Choice of Clones for Replanted Areas

Attention is directed to the circular on the above subject which appears in this issue.

Samples and Specimens forwarded by Estates for Examination

Attention is directed to the notice on the above subject which appears in this issue.

Arnold Sharples: Died 6th August, 1937

By a sad coincidence the notice of the death of Arnold Sharples, formerly Head of the Pathological Division of this Institute, appears in this issue along with the review of his masterly treatise on "The Diseases and Pests of the Rubber Tree." He had not long finished the writing of this book when he was overtaken by the illness which caused his premature death.

TAPPING OF BUDDED TREES*

BY

C. E. T. MANN

Introduction

During the lean years of the depression interest in new planting material and in experimental work which had as its main object the improvement of planting material was necessarily small. Practically no new planting was being undertaken, the young areas planted during the years 1927 to 1931 with buddings had not reached the bearing stage and the chief interest lay in the problems of economic production from mature areas.

Since the introduction of the Rubber Regulation Enactment in June, 1934, there has been a change in outlook and centre of interest. The problems of economic production have become less acute and interest is again centred on the subject of improved planting material. Under the provisions of the Enactment, replanting to the extent of 20 per cent of the acreage established prior to June, 1934, is permitted within the regulation period, and those who desire to take advantage of this provision are vitally interested in the choice of the new material to take the place of the unprofitable trees which are being removed.

We have heard a good deal of discussion during the past year concerning the respective merits of buddings of the best proved clones and seedlings of known origin and their relative value as planting material for present-day use. The discussion has aroused anew all the old objections to the practice of budding, although many of these objections had lost their force as evidence of the value of buddings of the best clones, particularly from the standpoint of yield, was gradually accumulated. But, the striking results which have been obtained in the first tapping tests on seedlings produced by careful breeding between selected clones, have had the effect of attracting renewed attention to certain undesirable qualities of budded trees.

General surveys of the information available concerning buddings and seedlings derived from clones have been given on previous occasions. It is not intended on the present occasion to continue the discussion of the relative merits of these two principal types of

* The greater part of this paper was embodied in a lecture given by the author at the Annual Conference of the Incorporated Society of Planters on 2nd October, 1936, but it has been revised and brought up to date since.

superior planting material, but to deal more fully with the subject of budded trees and their treatment.

A careful examination of the criticisms of budded trees reveals that many of the objections to buddings are based on a close comparison of buddings with seedlings. It is quite easily understood that a planter will form a clear conception of what he considers to be the ideal rubber tree. Since the conception is based on experience the ideal tree will have the characters of a seedling. There will be a natural tendency to distrust material which does not conform with this preconceived standard of quality and appearance. Judged by this standard, budded trees must inevitably suffer, as they differ in so many important respects from seedling trees. It is necessary to judge the merits of seedlings and buddings by quite different standards, one should not look at a budding with the "seedling eye."

Comparison of the Characters of Buddings and Seedlings in relation to Tapping Practice.

Although the essential differences between the vegetative characters of buddings and seedlings are probably familiar to you it will be as well to describe them in order to show how the differences in form should be taken into consideration in determining the future treatment of the trees.

(*a*) A typical seedling shows a more or less pronounced taper from the level of the lateral roots to a height of about four feet. The decrease in circumference is rapid over the first foot from ground level, becoming more gradual with increase in height until, above a height of about fifty inches, the trunk becomes practically cylindrical up to the level of the first branches. The trunk of a budded tree is almost cylindrical from the level of the union with the stock up to the level of the first lateral branches. Girth measurements taken at heights of 10 inches, 30 inches and 50 inches on buddings of a typical clone gave readings of girth of 30 inches, 28 inches and 27 inches respectively. Comparisons of girth measurements on large numbers of seedlings and buddings show that the difference in girth at heights of 20 inches and 40 inches is only 5 per cent in buddings, whilst in seedlings the mean difference is 15 per cent. The girth of a seedling tree at ground level may be double the girth at a height of 40 inches, whilst the difference in girth at corresponding levels on a budding is seldom more than 10 per cent.

(*b*) In a normal seedling tree, accompanying the gradual decrease in girth there is a corresponding decrease in bark thickness from the base of the tree upwards. This change in the thickness of the bark is accompanied by a change in structure both in the outer lay-

ers and the inner layers of the bark. The structure of the outer layer of bark will be dealt with in more detail later; the innermost layers of bark which contain the latex vessels, are of particular interest here. Examination of the productive layer of soft "bark" shows that in a normal seedling tree the number of latex vessels at the base of the tree is approximately 50 per cent greater than the number found at a height of 40 inches.

In a typical budded tree the difference in bark thickness measured immediately above the union and at a height of 40 inches is small, and seldom exceeds 15 per cent. Corresponding with this uniformity in thickness is a uniformity in structure, both of the outer, corky layer and of the inner, soft layer containing the latex vessels.

TABLE I

Distribution of Latex Vessels in the Bark of Buddings and Seedling Trees at different Heights.

Type of Tree	Number and Percentage of Latex Vessels at heights of :—		
	5 inches	20 inches	40 inches
1. Buddings ...	20 *100%*	19 *95%*	18 *90%*
2. Seedlings ... (Unselected) ...	15 *100%*	11 *73%*	9 *60%*
3. Selected Seedlings ... (Mother trees of the buddings in 1) ...	20 *100%*	15 *75%*	— —

To illustrate this important difference in the quality of the bark of buddings and seedling trees the results of a detailed examination of bark sections taken at heights of 5, 20 and 40 inches from ground level on buddings and seedlings are summarised in Table I. The examination was made on 208 buddings of six different clones and 485 seedlings of mixed origin. The buddings were just over five years of age and the seedlings seven years of age. The actual number of latex-vessel rows in the buddings was considerably higher than that in the seedlings at all levels, but for the present this is not the point to which I wish to draw attention. The relative proportion

of latex-vessels at different levels is here the chief point of interest; in buddings, if the full count of latex vessels at the base of the trunk is taken as 100, then at 20 inches the number is reduced by only 5 per cent and at 40 inches by only 10 per cent. For seedlings, the corresponding figures are 100 per cent at the base of the tree, which is reduced by 27 per cent at 20 inches and by 40 per cent at 40 inches. It may be suggested that to compare the bark of buddings of good clones with that of a group of ordinary unselected seedlings is hardly a fair comparison. To meet this objection, the ten highest-yielding trees of the group of seedlings examined have been considered separately, and it is again found that the number of latex-vessels at 20 inches is less by 25 per cent than the number at the base of the tree. It is a point of interest that these selected seedlings include the mother trees of the buddings with which these comparisons are made.

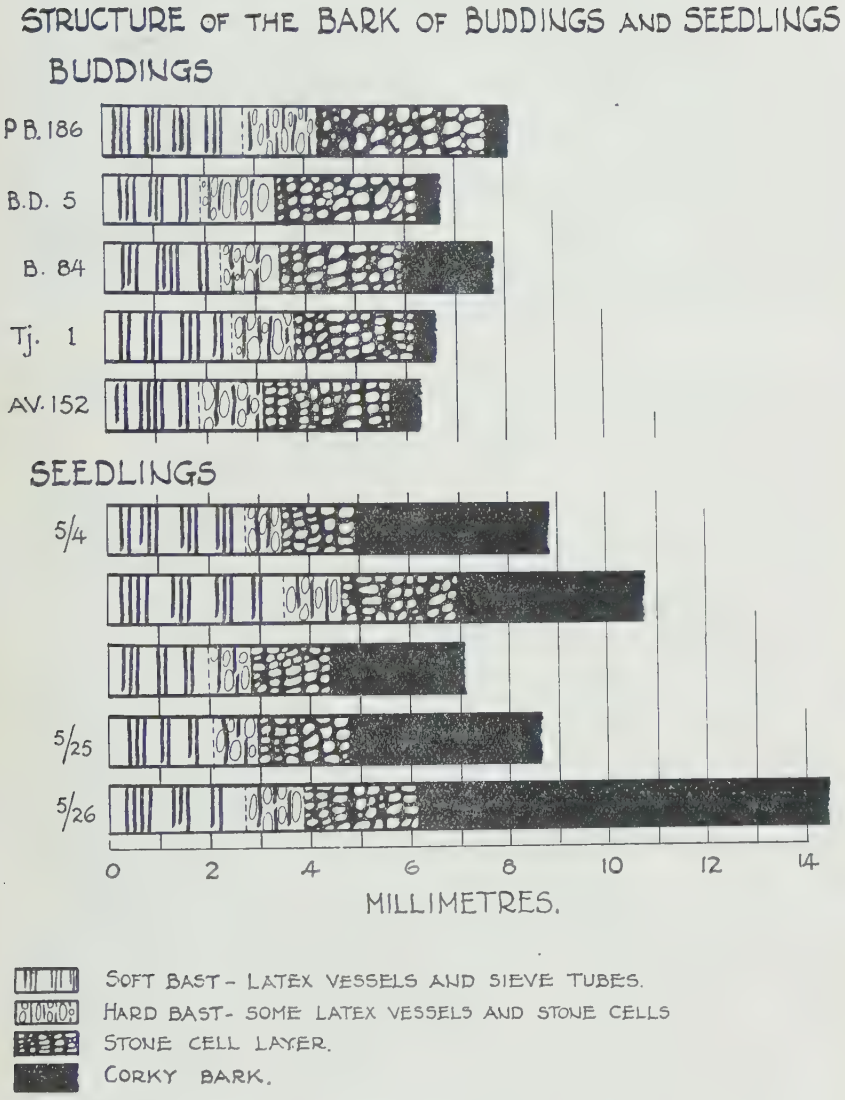
The characters discussed so far, changes in girth and the quality of the bark with increase in height on the trunk, have a very close bearing on yield and tapping practice. In seedling trees it is clear that the highest production will be obtained at the lowest levels, where the maximum length of the tapping cut on bark of the best quality is obtained. Before considering the question of yield in more detail, there is a further characteristic difference between the bark of buddings and seedlings which must be described.

(*c*) It is the common practice to speak of the whole of the tissues outside the wood of a rubber tree as the bark. Although this may not be correct botanically the term is clearly understood in relation to tapping practice, and we will retain it for the purpose of this discussion.

The "bark" is separated from the wood by the actively growing cambium layer from which new wood vessels are formed towards the inside and new bark tissues towards the outside. A longitudinal section taken through the bark shows that it is made up of an inner layer of soft tissue, an intermediate layer consisting of a mixture of soft tissue and harder elements known as stone cells, and an outer layer composed of hard, and for the most part dead, cells consisting mainly of cork. (Strictly speaking only this hard outer layer is the true *bark;* the inner living layers constitute the *bast*). The relative extent of these three principal zones of tissue varies considerably in seedling trees. Different clones may also show considerable differences in bark structure, although within a single clone the buddings show a high degree of uniformity in this respect.

The most important tissues, from our point of view, the latex-vessels, are practically confined to the inner layer of soft bark and the innermost layers of the stone cell zone. Outside this region no latex occurs.

FIGURE 1



In Figure 1 the relative extent of the different tissues in the bark of typical buddings and seedlings is shown diagramatically. The most noticeable difference in the bark structure of seedlings and buddings which the diagrams reveal is the relatively small development of cork on the bark of buddings. In seedling trees the non-latex-bearing corky layer represents from one-third to one-half of the total bark thickness. In most budded trees this cork layer accounts for less than 10 per cent of the total bark thickness. Clone B.84 is quite exceptional among the better-known clones in this

respect; the cork layer on buddings of this clone may represent 25 per cent of the total bark thickness. A further interesting feature is the relatively greater development of the stone cell layer, the zone between the cork and the soft bark, in buddings as compared with seedlings. It appears that the deficiency in the corky, protective layer is to some extent counterbalanced by a heavier development of protective tissue below the cork layer. The actual thickness of the latex-bearing zone is approximately the same in the buddings and the selected seedlings examined. The sections used to illustrate these differences in the structure of the bark of buddings and seedlings have been prepared from samples of bark taken at an uniform height of 20 inches on trees about 6½ years of age.

These essential differences in bark structure between buddings and seedlings have been the source of the most numerous criticisms and doubts concerning the value of buddings.

In seedling trees the heavy development of cork is most pronounced at the base of the tree within the normal tapping levels. Usually, the development of a thick cork layer is absent from the upper portions of the trunk and the main branches, so that the bark becomes smooth and similar in appearance and texture to that of a budding. That a heavy cork layer is normally present on bark which it has been the custom to tap appears to have been responsible for a firmly fixed belief that there must be something fundamentally unsound in the practice of tapping bark which is not provided with a heavy cork layer. In any discussion of tapping of budded trees the objection to tapping "branch" bark is generally heard. It is difficult to find actual evidence that branch bark could not be tapped satisfactorily if it were found profitable to do so. Without this evidence the objection to tapping "branch" bark and its application to budded trees is without foundation. The main point it is desired to make is that differences are not necessarily defects; satisfactory answers to criticisms can be obtained only from the results of practical tests.

There is one important respect in which the differences in structure of the bark have an important practical bearing. Although the corky layer of the bark of a seedling tree contributes nothing to the yield of latex, during the actual tapping operation it provides a firm channel along which the tapper's knife can work smoothly. The tapping knife is steadied by the extra resistance of the tough, corky layer and the risks of too-deep tapping and wounding are minimised. Tappers who have been accustomed to work on ordinary seedlings will at first experience some difficulty in tapping buddings. They will either be inclined to wound frequently or, if they have been suitably impressed beforehand concerning the dangers of wounding,

tapping is likely to be too shallow. This is a practical difficulty which can be overcome by a little careful attention in the early stages.

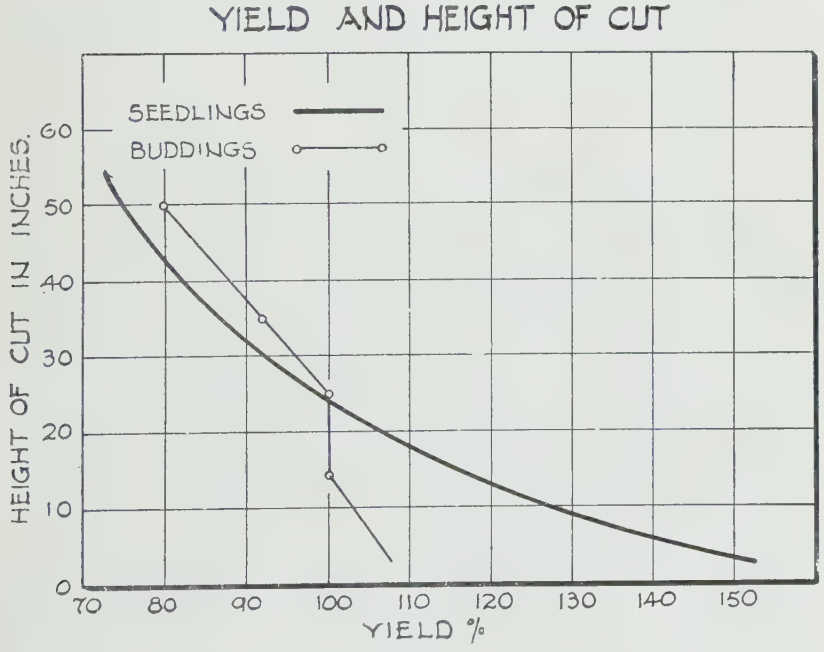
The absence of the thick cork layer on buddings reduces the width of the channel available for the flow of latex at tapping. If the tapping cut is given the same slope as that normally used on seedlings there is a tendency for latex to overflow down the bark. Tapping with a steeper slope at about 30 degrees overcomes this difficulty.

It is now proposed to describe briefly certain experiments which illustrate the bearing of the special characters of budded trees on the choice of a tapping system.

Yields of Buddings and Seedlings at different Tapping Heights

It is well known that the yield of a seedling tree decreases with increase in the tapping height. The relationship between the height of cut and yield is shown in Figure 2.

FIGURE 2



Yield at a mean height of 25 inches is taken as 100, and it is found that at ground level the yield is increased by 50 per cent; at a

height of 50 inches the yield is reduced by 25 per cent. In the same Figure a second curve is drawn from records obtained from budded trees of a single clone. It is regretted that the data are so limited, but they are sufficient to illustrate that the change in yield with increase in the height of the tapping cut is much less marked in buddings than in seedlings. The lower portion of the curve has not been completed as the yields of buddings of different clones vary considerably as the tapping cut approaches the union.

More complete records are available for yields of budded trees tapped at heights of 20 inches and 40 inches. For buddings of 11 clones the average yield during the first tapping year on buddings opened at a height of 40 inches is found to be almost exactly 10 per cent less than the yields of trees opened at a height of 20 inches. Reference to the curve in Figure 2 shows that for seedling trees the mean difference in yield between trees tapped at corresponding heights is more than double this figure. Certain clones appear to give practically the same yield at tapping heights of 20 inches and 40 inches.

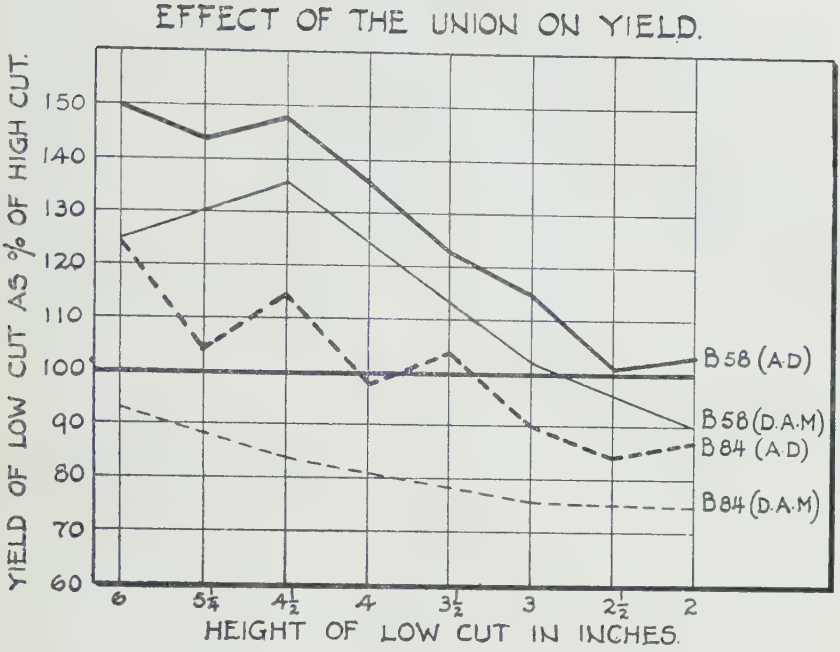
The essential differences in the structure of the tapping zone in buddings and seedlings are thus shown to have an important bearing on yield. It is clear that in the choice of a tapping system which will prove satisfactory for budded trees, full consideration must be given to their special characteristics. It is unlikely that the systems which have been proved by long experience to be satisfactory on seedling trees will be the best systems for buddings.

The Effect of the Union on the Yield of Buddings

The graph illustrating the relationship between yield and tapping height in seedling trees shows a steady increase in yield as the tapping cut approaches the base of the tree. Over the lowest section of bark the increase in yield is most pronounced. In budded trees we find that the reverse is true. In general it is found that, as the tapping cut approaches the union, yields do not increase but may actually decrease. The behaviour of different clones is not uniform. Certain clones may begin to show this "union effect" when the tapping height is still several inches from the union; in others it is not apparent until the tapping cut reaches a much lower level.

To illustrate this point I have taken the results of an experiment carried out on two clones. In each clone the yields of two groups of trees tapped at heights of 6 inches to 2 inches above the union are compared with trees tapped from 40 inches to 36 inches above the union. The figures are given in Table II and illustrated graphically in Figure 3.

FIGURE 3



Two systems of tapping were used, alternate-daily tapping and daily tapping in alternate months.

TABLE II

The Effect of the Union on Yield of Buddings.

Yield of lower cut expressed as a percentage of the yield of the upper cut.

Clone	Tapping System	Heights of Tapping Cuts in inches							
		40	39¼	38½	37¾	37	36¼	35½	34¾
		6	5¼	4½	4	3½	3	2½	2
B. 58	a.d.	150	144	149	138	123	115	100	103
	d.a.m.	121		136			101		90
B. 84	a.d.	125	104	115	98	104	90	83	87
	d.a.m.	93		84			76		75

The results of these experiments demonstrate clearly the *relative* decline in yield which takes place as the tapping cut approaches the union. The word *relative* is important; it should not be assumed that there was a pronounced fall in yield on the lower tapping cut (actually there was a slight increase in yield); the important point is that yields from the upper cuts increased more rapidly than yields from the lower cuts. The difference between clones is also illustrated by the examples selected. In Clone B.58, although the yield of the upper cut increases more rapidly than that of the lower, the latter still remains the higher-yielding cut to within two inches of the union. In Clone B.84 the rate of increase in the yield of the upper cut is relatively more rapid, and its yield exceeds that of the lower cut when the latter is about 4 inches from the union on trees tapped on the alternate-day system.

It will be noticed that with the daily alternate-monthly system of tapping the effect of the union on yield appears to be considerably more marked. This is evident in Clone B.58, and quite pronounced in Clone B.84.

From the results of experiments carried out elsewhere it has been recommended that budded trees should be left untapped from six to eight inches from the union. The results on which this advice is based were obtained with the daily alternate-monthly system of tapping. It is interesting to note that the results obtained with Clone B.84 in the present experiments would support this recommendation. At the same time, as the most usual system of tapping in this country is the alternate-day system, in view of the results we have obtained it appears to be unnecessary to discontinue the tapping of buddings until a considerably lower level is reached when the alternate-day system of tapping is used.

Bark Renewal on Budded Trees

Of all the doubts which have been expressed concerning the value of buddings probably the most numerous have been on the subject of bark renewal. One of the alleged defects of "branch bark" is that it will not renew. It is unfortunate that some of the earliest clones to be tested were used for commercial planting before information was available concerning their secondary characters, particularly bark renewal. Although, as soon as weakness in this respect was observed, the defective clones were removed from the list of those recommended for planting, the warning came too late to prevent the planting of considerable areas with unsatisfactory clones. It seems likely that many of the rumours concerning the defects of budded trees have their origin in these unfortunate areas. Such characters as thinness

of the primary bark and a slow rate of bark renewal are clonal characters. Before a clone can be recommended for commercial planting it is now necessary to obtain conclusive evidence that secondary characters of this nature are satisfactory. It is not sufficient that a clone should give a very high yield in the early years of test, other characters are of almost equal importance.

In an area containing buddings of a number of clones which have been tapped continuously since 1928, we have made regular observations on the rate of bark renewal. The records for two clones are given in Table III, and they show that the rate of bark renewal has been entirely satisfactory.

TABLE III

Bark Renewal in Buddings of Clones B.84 and D.65.

Clone	Thickness of Bark in millimetres								
	Virgin Bark at heights of :—		Renewed bark :—age in years						
	4 in.	50 in.	7	6	5	4	3	2	1
B. 84	11.8	11.3	10.4	10.3	10.2	10.1	8.8	8.4	7.4
D. 65	11.7	10.4	9.8	9.4	9.3	8.8	7.1	6.4	5.7

In addition to the measurements of thickness, examinations of the structure of the bark have been made. It has been found that after four years the structure of the inner layer of renewed bark is practically identical with that of the virgin bark. The difference in total bark thickness is accounted for mainly by the smaller development of the stone-cell layer in the renewed bark.

During 1935 renewed bark representing seven years renewal was tapped, and it was possible to make careful comparisons between the yields of trees tapped on renewed bark and virgin bark at the same tapping height. Six clones were included in the comparison. It was found that as the tapping cut approached the renewed bark, yields decreased slightly below the level obtained on trees having virgin bark below the tapping cut. As the tapping cut entered the renewed bark there was an increase in yield, more marked in some clones than others, but in all clones the yield on renewed bark was relatively higher than on virgin bark at the same height.

It is not possible to give in full the detailed results here, but the figures summarised in Table IV show that, despite the fact that many of the trees were tapped on renewed bark during 1935, all clones except D.65 showed an increase in yield.

TABLE IV

Yields of Buddings tapped on Renewed Bark

Tapping system: alternate-day on half-circumference.

Year	Nature of Bark	Tapping Height in January	Yield in pounds per tree per annum					
			A. 44	B. 58	B. 84	D. 61	B. 16	D. 65
1933	Virgin	40 in.	9.3	9.6	15.9	7.1	15.1	20.0
1934	„	30 „	9.5	12.9	18.5	10.9	18.6	26.0
1935	Renewed	20 „	10.0	14.6	19.2	11.8	19.1	23.2

Rate of Increase in the Yield of Buddings

Although it is generally accepted that buddings of the best clones now recommended for planting are capable of very high yields when young, there appears to be a general impression that they will not be able to maintain their yield or show a steady increase in yield with age in the same manner as seedlings. This is still another of the questions which will only be answered with certainty by future results, but from our present evidence there seems to be little reason for anxiety.

In Figures 4 and 5 the yield records of two good clones are shown. Although the trees have been tapped continuously from the time they reached a girth of 16 inches, there is little evidence so far that their good performance at an early age has not been maintained.

It is of interest also that young buddings made in 1928 from the original buddings of Clone B.84 have now been tapped for three years and have given the following yields:—

6th year	7.2	pounds per tree.
7th year	9.4	„ „ „
8th year	11.2	„ „ „

So far they are repeating fairly closely the performance of the original buddings.

FIGURE 4

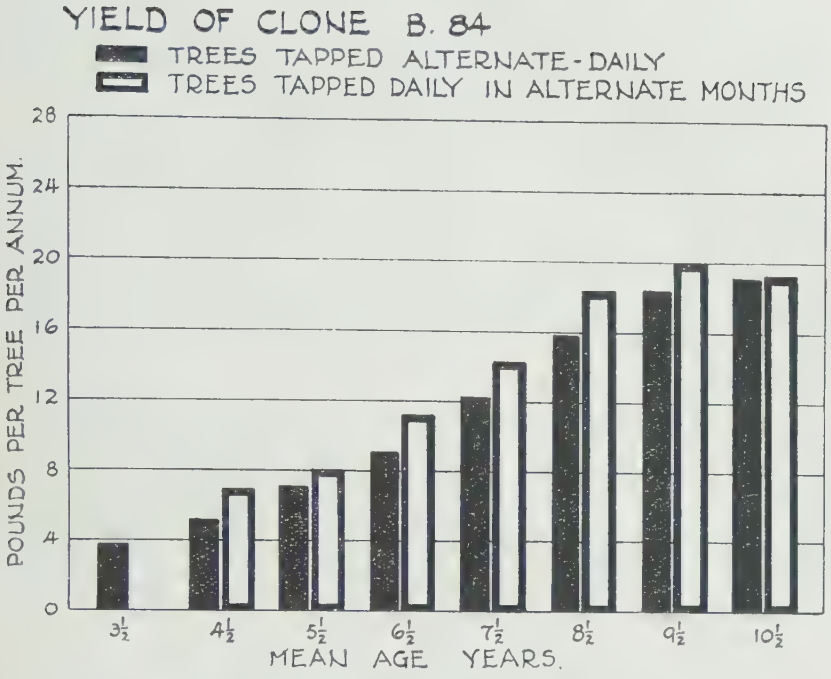
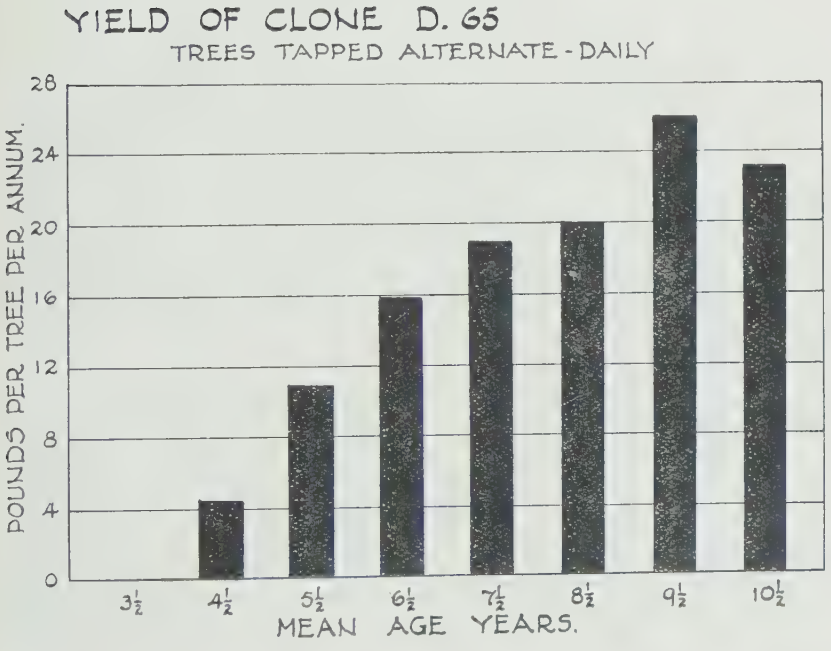


FIGURE 5



Practical Considerations in the Tapping of Buddings

From the experience and information we have gained from tapping experiments on a large number of different clones it is recommended that tapping of buddings should be commenced on the following system:

(i) The minimum girth for commencement of tapping should be not less than 20 inches at a height of 40 inches from the union of bud and stock.

(ii) Trees should be opened on a half-circumference, the lowest point of the tapping cut being 40 inches from the union. (For clones B.D. 5 and P.B. 186 a lower initial tapping height may prove necessary).

(iii) We prefer the single, spiral cut sloping downwards from left to right at an angle of about 30 degrees, but where there is a particular preference for the "V" cut it may be used. The chief advantage of the half-spiral cut is that it is quicker to tap than the "V" and probably gives a slightly higher yield. On the other hand, the "V" cut reduces the danger of loss of latex by overflow from the cut.

(iv) Tapping alternate-daily with bark consumption of $\frac{3}{4}$ to $\frac{7}{8}$ inch per month is recommended for the first two years.

It has been shown that by tapping on the A.B.C. system or tapping every third day, very satisfactory yields per acre can be obtained from young buddings and the yield per tapper can be appreciably increased.

There are one or two minor points of practical importance. It should not be forgotten that the heavy cork layer on the bark of a seedling tree provides a useful anchorage for the spout and cup-hanger: the spout can be forced into the corky bark to a fairly deep level without causing damage; similarly, the usual type of cup-hanger which is held in position by two short claws pressed into the bark is generally satisfactory on seedlings. Greater care is required on buddings, spouts of lighter construction are required and the expanding type of cup-hanger which does not penetrate the bark should be used.

In tapping seedlings a fairly broad-bladed knife or gouge may be used (one-half or five-eighths inch gouges are in general use). For buddings we have found a three-eighths inch gouge to be much more satisfactory.

It is realised that in the older areas where buddings and seedlings have been planted together it will probably prove difficult to give buddings the different treatment their differences in character require. In view of the differences in bark thickness and structure, tapping

will be difficult. There will be a tendency either to tap too deeply on the buddings or, if the buddings are correctly tapped, then it is likely that the seedlings will not be tapped deeply enough. If possible it should be arranged that different tappers are allocated to buddings and seedlings or, it might be feasible to arrange that the buddings and seedlings are tapped on alternate days. In large blocks containing only budded trees, particularly if the monoclone system of planting has been followed, the practical difficulties of tapping will be minimised. The general uniformity of the trees should actually make the tapping of buddings very much easier than the tapping of seedlings in which the variation in bark conditions from tree to tree may be very great.

Yields obtained from Budded Areas tapped under Normal Estate Conditions

It is discouraging to us, and not very helpful to you, when confirmatory evidence of the value of buddings is required, that actual records of the yields of large budded areas in commercial tapping are difficult to obtain. The chief reasons for this lack of information are :—

(*a*) The extensive planting of buddings of clones which can now be regarded as "proved," (or, more correctly, approved) dates from about 1928, so that the trees would not have been ready for commercial tapping much before 1934;

(*b*) the introduction of Rubber Regulation has made it unnecessary to tap young areas prior to 1937. It has generally been possible hitherto for an estate to obtain its full exportable quota from mature areas at a lower tapping cost than it would be possible to maintain even from a high-yielding area of young buddings. Under the conditions which have prevailed up to the present, cost per pound has been a more important consideration than yield per acre.

Although the area is small, a fair index of the yield per acre obtainable from buddings of the best clones can be prepared from our records of an experimental area. The records are summarised in Table V.

The block was planted in 1924 and the actual area allocated to each clone is accurately known. This figure is used to compute the yield per acre for each clone. No allowance is made for losses. Since 1931 the method of tapping, collecting and manufacture of the rubber has been made to conform as closely as possible with ordinary estate practice. The crop from each clone is manufactured as smoked sheet and lower grades are made up as crepe in the usual way. The total weight of dry rubber obtained from each clone is recorded monthly.

TABLE V

Records of Yield per acre from an Experimental Area planted with Buddings.

Clone	Acreage	Yield per acre in pounds No. of Trees per Acre				
		1931 6 to 7 years	1932 7 to 8 years	1933 8 to 9 years	1934 9 to 10 years	1935 10 to 11 years
Clone A. 44	1.34	590	613	530	503	491
		73	64	58	53	53
Clone B. 58	.84	743	864	845	983	1,049
		79	78	78	77	77
Clone B. 84	.50	735	959	1,068	1,273	1,258
		66	68	70	70	68
Clone D. 61	.46	467	549	479	634	695
		52	52	57	56	56
Clone D. 65	.06	1,232	1,423	1,409	1,668	1,530
		72	72	72	72	72
Clone B. 16	1.08	792	906	998	1,128	1,188
		64	63	64	63	62
All Clones (Mean)	4.28	760	886	888	1,032	1,035
		68	66	67	65	65
(See foot note)						

Under the rules for the assessment of untapped rubber the following maximum allowances are given for budded rubber (Controller of Rubber. Circular, 10th October, 1934).

Age in years ...	*6 to 7*	*7 to 8*	*8 to 9*	*9 to 10*	*10 to 11*	*11 to 12 and older*
Stand per acre ...	*110*	*105*	*100*	*90*	*85*	*85*
Yield per acre in pounds per annum ...	*600*	*750*	*900*	*1,000*	*1,100*	*1,200*

The figures presented in Table V give an accurate record of the actual yields per acre obtained from the different clones. The stand of trees per acre is low, considerably lower than it would be in a present-day planting, and it is reasonable to expect that even better results would have been obtained with a higher initial density of planting. Attention is directed to the footnote to Table V.

Further records of yield are available from comparatively large blocks of buddings of a number of clones in monoclone plantings. The blocks are from 60 to 70 acres in size and each block contains 18 tapping tasks. Tapping is alternate-daily with a single cut from left to right commencing at a height of 40 inches from the union. During the first tapping year the following yields have been obtained :—

	Age of Buddings at Commencement of Tapping	Yield in pounds per acre
Clone P.B. 25	... 5 years	578
Clone S.R. 9	... 6 „	324
Clone A.V.R.O.S. 49	... 5½ „	517
Clone A.V.R.O.S. 50	... 5½ „	464
Clone A.V.R.O.S. 152	... 5½ „	393

At the conclusion of the first tapping year the blocks of 18 tasks have been divided into three sub-groups each containing six tasks. The first group is tapped alternate-daily, the second on the A.B.C. system with periods of six months tapping and three months rest; the third group is tapped every third day.

The results obtained with Clone P.B. 25 follow; for the other clones the work is not yet sufficiently advanced for discussion.

Clone P.B. 25.—Buddings six years of age at the commencement of the experiment :

Tapping System	A.D.	A.B.C.	Third-daily
**2nd year*			
Yield in lb. per acre	*757*	539	543
Yield as % of A.D.	*100*	*71*	*72*
Mean yield per tapper in lb. dry rubber	13.2	14.0	14.0
3rd Year.			
Yield in lb. per acre	935	704	*725*
Yield as % of A.D.	*100*	*75*	*77.5*
Mean yield per tapper in lb. dry rubber	16.1	18.0	18.6

* *During the first year all tasks were tapped on the alternate-daily system. When the comparison of the three systems of tapping was commenced the tapping height on all trees was 30 inches from the union.*

The yields from the tasks tapped alternate-daily are excellent, and they are well in excess of the maximum allowance for budded rubber of this age permitted by the rules for the assessment of young areas.

The yields obtained under the A.B.C. and third-day systems of tapping are also very satisfactory. Production in pounds per acre is practically the same on both systems. The proportional loss in yield is less than the proportional reduction in number of tapping days. It is clear, therefore, that the trees are deriving some benefit from the extra rest allowed by the lighter tapping systems. A point of particular interest at the present time is the very satisfactory yield per tapper obtained on the lighter systems of tapping. A yield of 18 pounds per cooly on a task of 300 trees which are not yet eight years of age, reckoned from the date of budding, is exceptionally good.

TABLE VI

Summary of Yield Records of young Budded Trees from Tests carried out on Estates.

Clone	Yield in pounds per Tree			
	1st Tapping Year		2nd Tapping Year	
	No. of Trees	Yield	No. of Trees	Yield
Tj. 1 ...	*(3)* 38	7.9	*(1)* 10	11.8
A.V.R.O.S. 49 ...	*(3)* 5440	4.6	*(1)* 20	5.8
A.V.R.O.S. 50 ...	*(3)* 5513	4.8		
A.V.R.O.S. 152 ...	*(2)* 5418	3.6		
B.D. 5 ...	*(3)* 28	4.4	*(1)* 20	7.6
B.D. 10 ...	*(2)* 27	5.9	*(1)* 20	6.1
P.B. 25 ...	*(1)* 5400	5.7	*(1)* 5400	7.2
P.B. 23 ...	*(1)* 13	4.7		
P.B. 186 ...	*(1)* 21	4.7		
S.R. 9 ...	*(1)* 5400	5.0		
A. 44 ...	*(3)* 56	8.6	*(2)* 39	9.6
B. 84 ...	*(3)* 60	6.8	*(2)* 40	9.9
B. 16 ...	*(2)* 40	9.2	*(2)* 40	11 6
D. 61 ...	*(2)* 40	6.1	*(2)* 40	8.9
B. 58 ...	*(2)* 40	6.7		

* *Numbers in brackets indicate number of sources from which records have been obtained.*

From a number of estates on which buddings have now reached the tapping stage we are receiving regular records of yields. On the

whole, the yields are coming up to expectations. We should be glad to receive many more records of this type from estates where buddings of the best-known clones are now being tapped. In Table VI a summary of the records from tests which have been continued for a full year or more is given.

Summary

1. In the course of this lecture the chief aim has been to illustrate the manner in which budded trees differ from seedling trees in many important respects. It is important that these differences should be fully appreciated as it has been shown that they have a most important bearing on tapping procedure.

2. Recommendations for the early tapping of budded trees are made and attention is drawn to details of practical importance in field practice.

3. Records of yields of buddings of a number of approved clones when tapped under normal estate conditions are presented. The results so far obtained support the records of early tests on the original series of buddings of the various clones.

4. An appeal is made for the further collaboration of estates in obtaining records of yields of budded areas, so that more may be learnt of the influence of environmental conditions on the performance of different clones.

EXPERIMENTS WITH ECONOMIC TAPPING SYSTEMS (1)

BY

C. C. T. SHARP

Parts IV and V

Part IV—Results of Tapping for the third Year, June 1935 to May 1936, of the Experiment on Seventh Mile Estate.*

One change in the tapping systems compared in this experiment has been made. Owing to the unavoidable increase in the bark consumption caused by the greater drying out of the tapping cuts with fourth-daily tapping, the double-four system (Plot 7) has been converted to double-four A.B.C.D. Starting from the 1st October, 1935, each section of the double-four plots is to be rested in turn for four months, the remaining three sections being tapped on two cuts every fourth day as before.

TABLE XVII

Yields June 1935—May 1936

Total yield per plot (lb. dry rubber) excluding Scrap

Block	Plots and Tapping Systems							
	1	2	3	4	5	6	7	8
	A.B.C. 6-3	A.B.C. 10-5	A.B.C. 14-7	Sunderland 3-3	Sunderland 5-5	Sunderland 7-7	Double-four	Alternate daily
I	2,587.3	2,857.4	2,561.4	1,787.7	1,969.3	1,941.7	4,345.3	2,054.0
II	2,950.1	2,664.3	2,510.3	1,888.3	1,803.9	1,835.4	4.745.8	2,123.6
III	2,697.4	2,476.6	2,594.7	1,601.1	2,057.8	1,531.6	3,992.5	1,924.2
IV	2,793.3	2,950.7	2,626.4	1,783.0	1,947.2	1,604.4	4,525.7	2,563 8
V	2,839.5	2,810.6	2,844.3	2,142.3	1,608.1	1,694.0	4,429.1	2,020.1
VI	2,488.3	2,281.8	2,024.8	1,591.5	1,664.2	1,572.8	3.975.9	2,234.4
	16,355.9	16,041.4	15,161.9	10,793.9	11,050.5	10,179.9	26,014.3	12,920.1

Grand Total = 118,517.9 lb.

* The previous papers in this series appear in this *Journal* **5** (1934) 320-341; **6** (1935) 105-110

TABLE XVIII

Yield in lb. per Acre for Third Year of Tapping of First-Grade Rubber, Scrap and Total Dry Rubber

	BLOCK	Plots and Tapping System							
		1 A.B.C. 6—3	2 A.B.C. 10—5	3 A.B.C. 14—7	4 Sunderland 3—3	5 Sunderland 5—5	6 Sunderland 7—7	7 Double-Four	8 Alternate-daily
First-Grade Rubber	I ...	482.9	533.4	478.1	417.1	459.5	453.1	507.0	575.1
	II ...	550.7	497.3	468.6	440.6	420.9	428.3	553.7	594.6
	III ...	503.5	462.3	484.3	373.6	481.5	357.4	465.8	538.8
	IV ...	521.4	550.8	490.3	416.0	454.3	374.4	528.0	717.9
	V ...	530.0	524.6	530.9	499.9	375.2	395.3	516.7	565.6
	VI ...	464.5	425.8	378.0	371.4	388.3	367.0	463.9	625.6
	Mean	508.8	499.0	471.7	419.8	430.0	395.9	505.9	602.9
	Per Cent. ...	84.4	82.8	78.2	69.6	71.3	65.7	83.9	100.0
Scrap	Mean ...	52.3	54.0	48.0	59.0	64.8	60.6	85.3	73.1
	Per cent of First-Grade Rubber	10.3	10.8	10.2	14.1	15.1	15.3	16.9	12.1
Total Dry Rubber	Mean ...	561.1	553.0	519.7	478.8	494.8	456.5	591.2	676.0
	Per Cent ...	83.0	81.8	76.9	70.8	73.2	67.5	87.5	100.0

General Mean = 479.3 lb. first-grade rubber per acre

TABLE XIX

Mean yield in pounds per acre per month, of First-Grade Rubber

(Third year of Experiment)

	1 A.B.C. 6–3			2 A.B.C. 10–5			3 A.B.C. 14–7			4 Sunderland 3–3			5 Sunderland 5–5			6 Sunderland 7–7			7 Double-Four			8 Alternate (Daily Control)		
	Yield			Yield			Yield			Yield			Yield			Yield			Yield			Yield		
	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent	Lb.	per cent	Total per cent
June 1935	40.5	84.9	80.5	39.1	82.0	78.9	38.7	81.1	75.7	25.5	53.5	62.9	35.3	74.0	69.5	38.6	73.9	63.8	53.9	113.0	106.7	47.7	100.0	100.0
July	43.9	86.1	80.7	42.0	82.4	79.0	38.2	74.9	75.7	41.3	81.0	63.6	29.6	58.0	69.1	36.1	70.8	64.1	55.0	107.8	106.8	51.0	100.0	100.0
August	44.0	84.5	80.8	46.3	88.9	79.4	38.4	73.7	75.6	37.0	71.0	63.9	38.5	73.9	69.3	38.2	73.3	64.4	53.1	101.9	106.6	52.1	100.0	100.0
September	37.3	77.4	80.7	41.7	86.5	79.6	36.1	74.9	75.6	27.6	57.3	63.6	38.4	79.7	69.6	29.8	61.8	64.4	49.0	101.7	106.4	48.2	100.0	100.0
October	42.9	86.1	80.9	39.3	78.9	79.6	38.3	76.9	75.6	39.4	79.1	64.2	33.3	66.9	69.5	23.3	46.8	63.8	39.2	78.7	78.7	49.8	100.0	100.0
November	42.7	84.4	81.0	40.6	80.2	79.6	44.1	87.2	76.0	32.8	64.8	64.2	36.7	72.5	69.6	35.9	70.9	64.0	35.8	70.8	74.7	50.6	100.0	100.0
December	49.7	81.9	81.1	50.7	83.5	79.8	47.1	77.6	76.1	35.4	58.3	64.0	36.5	60.2	69.3	41.3	68.0	64.2	44.5	73.3	74.2	60.7	100.0	100.0
Jan. 1936	46.9	89.8	81.3	45.0	86.2	80.0	44.1	84.5	76.3	40.8	78.2	64.4	45.5	87.2	69.8	34.8	66.7	64.2	40.3	77.2	74.9	52.2	100.0	100.0
February	41.5	82.0	81.4	43.5	86.0	80.2	38.4	75.9	76.3	39.3	77.7	64.8	40.6	80.2	70.2	30.1	59.5	64.1	33.3	65.8	73.2	50.6	100.0	100.0
March	34.8	77.3	81.3	36.5	81.1	80.2	32.8	72.9	76.2	25.1	55.8	64.6	33.1	73.6	70.3	27.5	61.1	64.0	30.1	66.9	72.3	45.0	100.0	100.0
April	46.3	95.5	81.6	38.1	78.6	80.2	40.5	83.5	76.4	40.8	84.1	65.1	33.1	68.3	70.2	32.1	66.2	64.1	37.4	77.1	72.9	48.5	100.0	100.0
May	38.3	82.7	81.7	36.2	78.2	80.1	35.1	75.8	76.4	35.2	76.0	65.4	29.2	63.1	70.0	28.2	60.9	64.0	34.6	74.7	72.9	46.3	100.0	100.0

NOTE 1: The thick horizontal lines show the points at which tapped and rested sections were changed over
NOTE 2: From 1st October 1935 one quarter of the area of plot 7 is rested in rotation

TABLE XX

Analysis of Variance. First-Grade Rubber (Third year)

	Degrees of freedom	Sums of Squares	Mean Squares
Treatments ...	7	181,384.2	25,912.0
Blocks ...	5	28,558.4	5,711.7
Error ...	35	49,811.4	1,423.2

TABLE XXI

Yield per Tapper and Comparative Cost of Tapping (Third year)

Tapping System	Yield per Tapper per Tapping			Comparative Cost per lb.		Comparative Yield per acre	
	First-grade rubber lb.	Scrap rubber lb.	Total dry rubber lb.	First-grade rubber per cent.	Total dry rubber per cent.	First-grade rubber per cent.	Total dry rubber per cent.
1	16.6	1.7	18.3	78.3	79.3	84.4	83.0
2	16.2	1.7	17.9	79.5	81.1	82.8	81.8
3	15.4	1.6	17.0	84.4	85.5	78.2	76.9
4	16.4	2.3	18.7	79.3	78.4	69.6	70.8
5	16.9	2.5	19.4	76.9	75.5	71.3	73.2
6	15.4	2.4	17.8	84.4	82.6	65.7	67.5
7	15.8	2.7	18.5	82.3	79.8	83.9	87.5
8	13.0	1.6	14.6	100.0	100.0	100.0	100.0

No change in the method of recording the experiment has been made and the results of the third year of tapping will be found in Tables XVII to XXII which are in continuation of the corresponding tables already published.

There is a small total loss in crop due mostly to the change of the double-four plots to a lighter tapping system.

TABLE XXII

Mean Dry Rubber Content (Third year)

Month		Tapping Systems							
		1	2	3	4	5	6	7	8
June	1935	41.9	39.4	38.7	46.5	38.3	39.4	40.0	40.3
July	„	40 7	42.3	39.1	42.0	47.9	38.8	40.8	40.8
August	„	40.6	40.5	39.6	41.9	43.1	39.3	41.4	41.6
September	„	43.1	41.0	40.2	46.2	41.0	40.2	41.7	42.0
October	„	42.4	40.9	43.0	42.5	40.2	47.2	41.2	42.2
November	„	41.3	40.6	41.2	40.5	39.6	42.5	41.0	41.5
December	„	43.2	43.5	40.0	46.7	46.6	40.6	41.4	41.3
January	1936	41.4	40.9	40.1	41.4	42.0	40.4	41.0	40.6
February	„	41.8	41.6	41.2	41.9	40.7	41.3	44.7	42.4
March	„	44.3	40.5	40.1	47.2	39.1	39.5	41.8	41.0
April	„	40.9	39.5	38.3	42.0	38.2	38.5	40.7	39.8
May	„	39.1	42.4	41.6	39.3	47.9	47.8	40.3	39.4

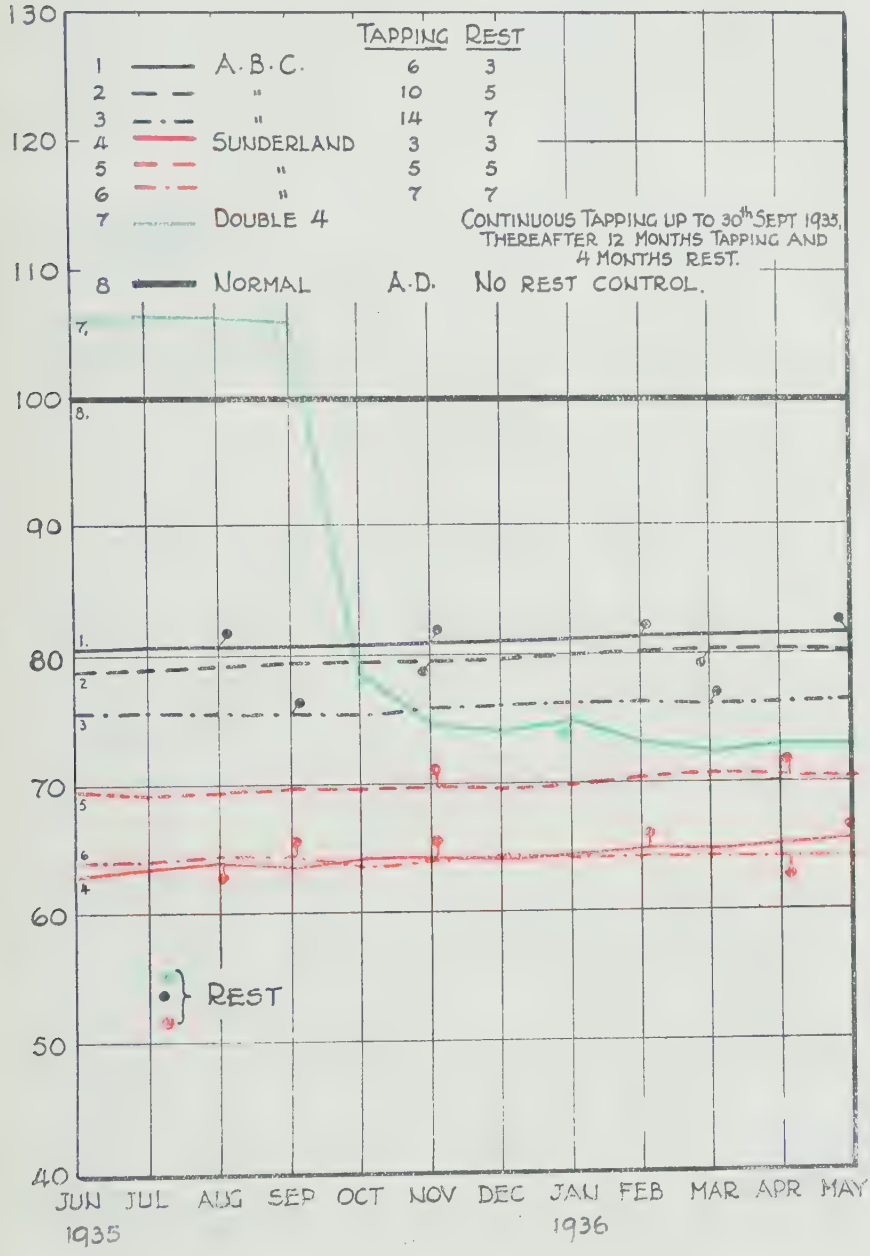
The horizontal lines show the points at which tapped and rested sections were changed over

In Table XIX and Fig. 4 which are in continuation of Tables VII and XIII and Figs. 2 and 3, the monthly variations of each tapping system are recorded. Except in the case of plot 7 the columns headed "Total per cent" show the total yields from the beginning of the experiment to the end of each month of the period under review expressed as a percentage of the control plots over the same period. In plot 7, owing to the change in tapping system, the method of computing the total yield per cent has been altered and the total yield per cent of the double-four A.B.C.D. system is expressed from 1st October 1935 as a percentage of the yield of the control from that date. Prior to that date the total yield as a percentage of the control has been calculated from the beginning of the experiment.

FIGURE 4

TAPPING EXPERIMENT ON 7th MILE ESTATE.

PROGRESS OF TOTAL YIELD AS PERCENTAGE OF CONTROL.
3rd YEAR.



From the analysis of variance (Table XXI) the error of the experiment has been estimated and has been found to be equal to 15.4 lb. or 3.2 per cent. Differences between the mean yield of first-grade rubber of the six plots of each tapping system (Table XIX) of less than 44 lb. or 9 per cent cannot therefore be regarded as significant. The error again shows a small reduction from that of the previous year.

A small increase in yield per tapper (Table XXII) is found in all tapping systems except 6 and 7. The comparative cost, however, is slightly greater in every case except 4, owing to the increase in yield of the control plots. None the less, there is still a considerable saving in tapping costs in all tapping systems compared with the control.

In calculating the comparative cost of tapping, the procedure adopted in previous years has been repeated; that is to say, to compensate for the lesser value of the lower grades, three-quarters only of the weight of the scrap rubber has to be added to the weight of the first-grade rubber. In the year under review there has been a far smaller difference in price than would be required to justify this method of computation, but since it is uncertain whether this difference will be permanent the method employed in previous years has been retained.

Discussion

In addition to the possible variations in the tapping system actually employed at the time, the yield obtained from any area of rubber is largely controlled by the nature of the bark tapped, whether virgin bark, first renewal, second renewal etc. It is also within the experience of most planters that the yield declines appreciably as the tapping cut approaches and crosses the junction between virgin bark and renewed bark, and a similar decline may occur between first and second renewal.

In this experiment the rate of bark consumption varies in the different tapping systems. In consequence of this, since it was decided to allow a period of ten years for the bark to renew in all systems compared, the opening heights of the tapping cuts were different in the different plots and the composition of the bark varies accordingly.

In Part I of this series the previous tapping history and the heights at which the tapping cuts were opened are given (Tables II and IV).

To make clearer the position of the tapping cuts in relation to the composition of the bark during the progress of this experiment, diagrams have been prepared showing the positions of the tapping cuts at the end of each year and the nature of the bark which the tapping cut has traversed. (Figs. 5 to 12).

In these diagrams the position at the end of each tapping year of the cut in each section of each plot is shown by the V-shaped black lines. The figures in the margin indicate the time at which the tapping cut reaches the position shown. Thus in Fig. 9, the tapping cut marked B.O. shows the position of the cut in section B at the commencement of the experiment, that marked A3 the position of the cut of section A at the end of the third year. In the latter case the bark traversed by the tapping cut during the third year of the experiment lies between the V-shaped lines marked A2 and A3.

The unshaded areas consist of virgin bark not previously tapped, the areas shaded black consist of bark that has been renewed once, and the areas shaded red of bark that has been renewed twice. The small area shaded black and red consists of bark that has been renewed three times, but this area will not be tapped during the course of this experiment.

Since the actual positions of the cuts are very unlikely ever to be in the exact position determined by the bark consumption programme, small differences in the positions of the cuts of the different sections of each plot are ignored.

Plot 8. Alternate-daily (Control)

During the first year of this experiment the tapping cuts were on virgin bark, and during the third year on first renewal. During the second year the tapping cuts approached and crossed over the junction between virgin bark and first renewal. The yields in lb. per acre for the first three years were 625.3, 581.2 and 602.9.

The drop in yield during the second year had the effect of exaggerating in comparison the yields obtained from the other tapping systems, whereas the recovery during the third year had the reverse effect.

Plots 1, 2 and 3. A.D., A.B.C. with three, five and seven months rest respectively

Compared with the control the yields of first-grade rubber have fallen by 2½ per cent., although the actual yields per acre have remained almost stationary. Reference to Figs. 5, 6 and 7 will show that during the first year the tapping cuts crossed from virgin bark to first renewal, during the second year they were all on first renewal and during the third year they approached or just cut the junction between the first and second renewal. Compared with the control an advantage in the composition of the bark in these plots occurred during the second year, when the control was suffering from a disadvantage, and a disadvantage occurred during the third year when the control tasks were on bark of uniform condition. Under

similar disadvantageous conditions the control plots showed an appreciable loss in crop, while the A.B.C. plots showed no loss in crop, an indication that the beneficial effect of resting periods on yield may still be increasing.

The differences in yield between these plots are not significant. Plots 1 and 2 have a significantly higher yield than the Sunderland system plots, and Plot 3 is significantly better than Plots 4 and 6.

Plots 4, 5 and 6. Sunderland system with resting periods of three, five and seven months respectively.

The effect of differences in the composition of the bark is complicated in the Sunderland system plots by the presence of two tapping cuts on opposite sides of the tree.

In Plot 4 (Fig. 8) the upper cuts were for nearly all the time on first renewal and the lower cuts passed from first renewal to second renewal.

In Plots 5 and 6 half the upper cuts passed from virgin bark to first renewal and the other half were on first renewal over two-thirds of their length, the remaining third just cutting the junction between first and second renewal. The lower cuts crossed or approached the junction between first and second renewal.

From the point of view of the condition of the tapped bark Plot 4 has an advantage over Plots 5 and 6, and this is reflected in the yields obtained, for the yield of Plot 4 increased by 19.4 lb. per acre, whereas those of Plots 5 and 6 decreased by 13.1 and 7.9 lb. respectively.

Compared with the control plots all these plots were at a disadvantage during the third year in respect of the condition of the bark tapped and, except in the case of Plot 4, a small decline in their comparative yields is recorded.

The differences in yield between the three Sunderland system plots are not significant. In yield they are all still inferior to the A.B.C. plots though they retain the small advantage in tapping costs.

Plot 7. Double-four

At the end of September 1935 this tapping system was abandoned and double-four A.B.C.D. substituted for it. During the period of 28 months, May 1933 to August 1935, the total yield of dry rubber was 6.4 per cent in excess of the control, and the tapping cost 74.7 per cent of the control.

Apart from this big saving in tapping costs this system of tapping appears to have no advantage over the normal alternate-daily tapping. It has, however, certain disadvantages, namely, a high bark consumption, a high proportion of scrap rubber, owing chiefly to the long period of flow of the latex, and a larger decline

Plan of Tapping Heights and Bark Consumption.

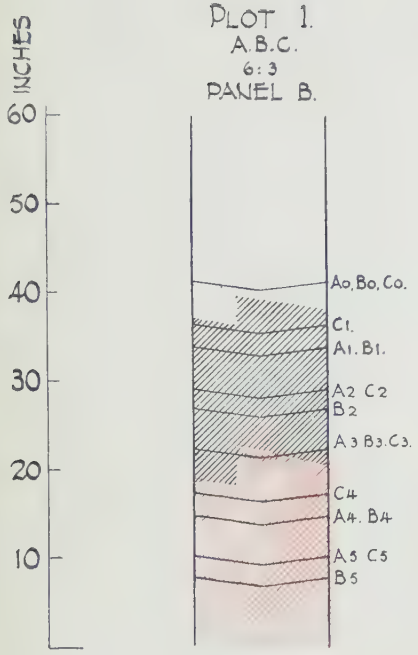


Fig. 5

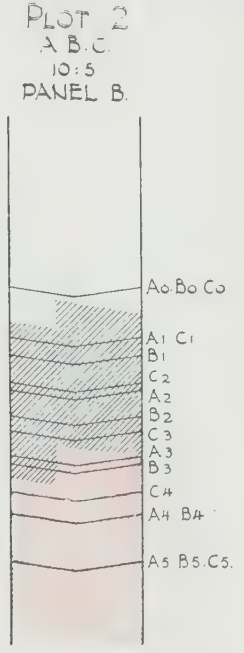


Fig. 6

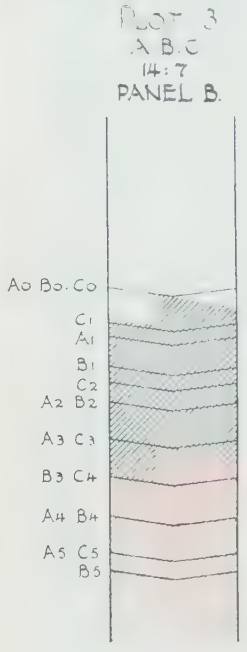


Fig. 7

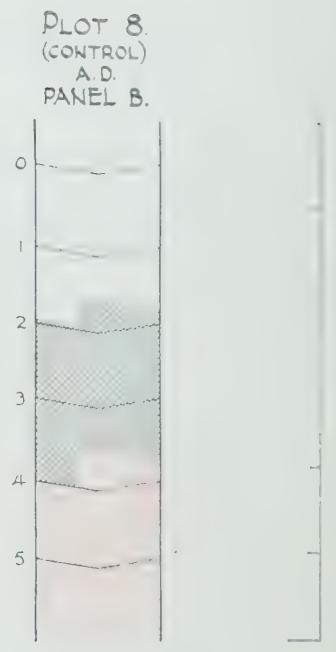


Fig. 12

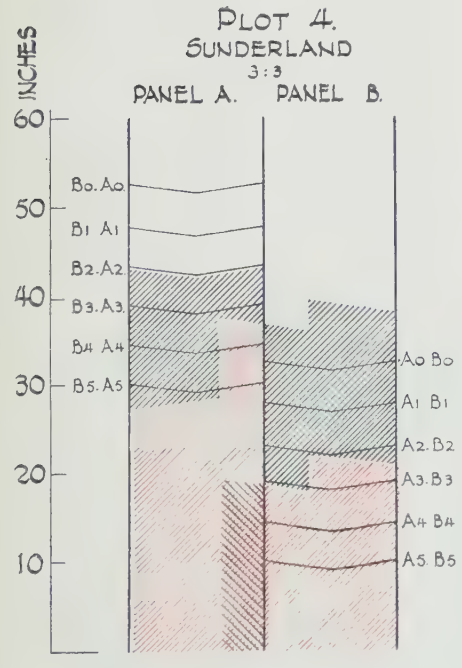


Fig. 8

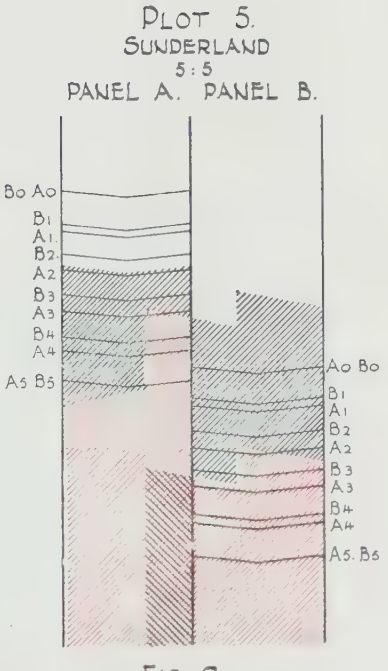


Fig. 9

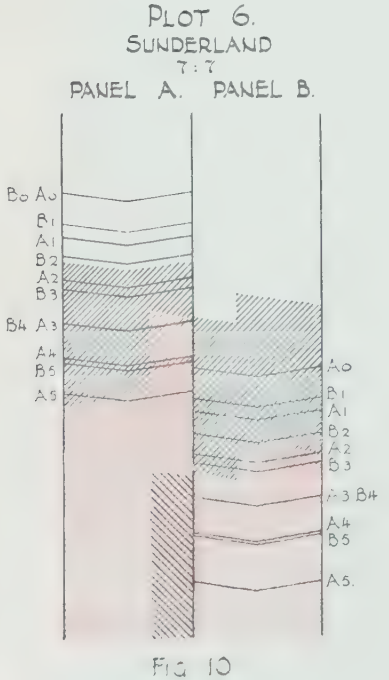


Fig. 10

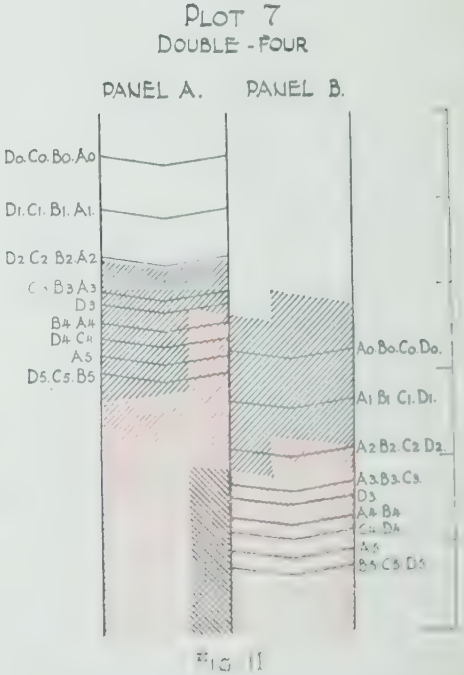


Fig. 11

in yield during wintering. This was very noticeable in 1935 when wintering was sudden, but much less noticeable in 1934 when abnormally heavy rain fell during the early part of the year.

Summary

The yields for the third year of the tapping experiment on Seventh Mile Estate are presented.

The effect of the varying consistency of the bark tapped on the yields obtained is discussed.

In consequence of this variation in the bark the trend of the yields during the third year is obscured. It will be necessary to wait for the results of the fourth and fifth years before more definite conclusions can be drawn.

Part V—Influence of the Tapping System on Rate of Bark Renewal

In September, 1936, measurements were taken of the thickness of the bark that had been renewing for three years.

These measurements were taken with the Lindeteves-Stokvis "Barkometer." Essentially, this instrument consists of a cylindrical rod one-eighth of an inch in diameter sharpened at one end to a wedge-shaped edge. This rod or plunger, is forced into the bark of the tree and the depth to which it penetrates is measured on a dial attachment to the nearest tenth of a millimetre.

There are two main disadvantages in the use of this instrument: the first that it not only records the thickness of the bark but may also include the cambium and the outer layer of the softer wood vessels in the measurement. The second disadvantage is the personal factor; different operators will apply different pressures and obtain different results. To obviate the second disadvantage all the measurements were taken by the writer.

With regard to the first disadvantage a number of measurements of the thickness of renewing bark were made by the writer with the Barkometer used in the experimental area. After measuring, a plug of bark surrounding the hole made with the plunger was removed with a cork-borer and a second measurement made with the Barkometer, but in this case the plunger was depressed until the point touched the exposed surface, and no further, *i.e.* it registered the thickness of the plug of bark removed, without penetrating the cambium. The mean difference between the two measurements was found to be 1.09 millimetres, and the figures of three years' renewal which are presented in Table XXIII have been adjusted by subtracting this amount from the recorded values of the bark thickness.

TABLE XXIII

Measurements of the Thickness of the Renewed Bark in September 1936

Plot	Tapping System		3 years renewal		3¾ years renewal	
			mm.	Per cent of Control	mm.	Per cent of Control
1	A.B.C. 6 : 3	...	4.53	105.1	7.05	99.0
2	A.B.C. 10 : 5	...	4.68	108.6	7.07	99.3
3	A.B.C. 14 : 7	...	4.87	113.0	7.16	100.6
4	Sunderland 3 : 3 — Upper Cut	...	4.99	115.8	5.90	82.9
	Sunderland 3 : 3 — Lower Cut	...	5.14	119.3		
5	Sunderland 5 : 5 — Upper Cut	...	4.76	110.4	6.06	85.1
	Sunderland 5 : 5 — Lower Cut	...	5.32	123.4		
6	Sunderland 7 : 7 — Upper Cut	...	4.85	112.5	5.92	83.1
	Sunderland 7 : 7 — Lower Cut	...	5.28	122.5		
7	Double-four — Upper Cut	...	5.24	121.6	5.96	83.7
	Double-four — Lower Cut	...	5.71	132.5		
8	A.D. (Control)	...	4.31	100.0	7.12	100.0
	Significant difference		0.37	8.4	0.29	4.1

Note.—The measurements of three years' renewal were taken above the present tapping cuts and the measurements of the 3¾ years' renewal at the bottom of panel A.

For reasons which will appear in the discussion of these results it was decided that one further measurement would be necessary. This measurement was taken in October 1936 at a point three inches above the bottom of panel A. That is to say, in tapping systems 1, 2, 3 and 8 it is near to the bottom of the panel opposite to the one now in tapping, and in the double-cut tapping systems it is near to the bottom of the panel on which the upper cut is situated. The measurements were taken by the Assistant Botanist and the figures in Table XXIII have received the necessary correction required when using the Lindeteves-Stokvis Barkometer. The bark at the base of Panel A at the time these measurements were taken was approximately three years and nine months old.

Discussion

The interpretation of these results is complicated by the fact that the rate of renewal increases as the height of the tapping cut decreases. This has been observed on many occasions and is again shown to be the case by the consistently greater thickness of the bark above the lower cuts than above the upper cuts in the double-cut tapping systems 4 to 7.

In the A.B.C. tapping systems there is a small average increase of 8.9 per cent in bark thickness compared with the control. This difference is significant but until the experiment is completed it will not be possible to determine how much of this increase is due to the lower height of the tapping cuts and how much to the influence of the resting periods.

On the other hand, the thickness of the renewal at the foot of panel A is equal to that of the control, from which it may be inferred that, with the A.B.C. tapping system, short periods of rest have not so far had any beneficial effect on the rate of renewal. At the same time it can be observed that the poorest renewal in these three plots is found in Plot 1, which gave the highest yield, and the best renewal in Plot 3, which gave the lowest yield. It appears likely that the slightly higher yield in Plot 1 has been obtained at the expense of part of the bark renewal.

In the Sunderland system plots the mean height of the points where the measurements were taken was approximately equal to that of the corresponding points in the A.B.C. plots, that is to say, at from 37 to 39 inches from the ground. The average increase in bark thickness above both cuts of Plots 4, 5 and 6 is 17.3 per cent of the control, or nearly double the amount obtained with the A.B.C. system. On the other hand, the bark below the upper cut, at the foot of panel A, shows a large falling off in the rate of renewal compared with the control, amounting to 16.3 per cent for the three plots.

In the double-four plots the measurements above the upper cuts were taken at the same height from the ground as in the control plots, and show an excess in the thickness of the renewed bark of 21.6 per cent.

The mean increase in thickness of the renewed bark above both the cuts is 27 per cent in excess of that of the control, and is significantly greater than the corresponding figures for the Sunderland system.

On the other hand, the thickness of the bark at the foot of panel A is equal to that of the Sunderland system, and it again appears that the short periods of rest of three, five and seven months which are received by the Sunderland system plots, although equal

in the aggregate to the tapping period, have had no beneficial effect on the rate of bark renewal. The partial girdling effect of two tapping cuts on opposite sides of the tree provides the most probable explanation of this increase in the double-cut systems in the rate of renewal above the tapping cuts, and the decrease in the rate below the cuts when compared with the single-cut systems.

The effect of the partial girdling of the tree may be briefly explained in the following way. The complex organic foodstuffs, elaborated in the leaves from simpler substances, travel through the sieve-tubes down the tree to the various parts at which growth is taking place. A large proportion of the functioning sieve-tubes are situated in the millimetre of bark which, with careful tapping, should be left uncut by the tapping knife. Although the sieve-tubes are not mechanically damaged by the tapping knife, the exposure of the inner layers of the bark by tapping causes an interference in the normal functioning of these tissues. This interference, though not complete—for if it were the tree would die—is sufficient to bring about an accumulation of food-stuffs above the tapping cut, and to stimulate growth in the areas where the bark is renewing. Below the tapping cuts the position is reversed, and the partial diversion elsewhere of the food-stuffs which would normally be available cause a retardation in growth of the renewing bark.

Summary and Conclusions

In the tapping experiment on Seventh Mile Estate measurements were taken of the thickness of the bark which had been renewing for three years.

Compared with the control plots which were tapped alternate-daily without rest it was found that

1. there is a small increase of 8 per cent in the thickness of the bark in the A.B.C. systems, which may be due to the lower height from the ground of the place where the measurements were taken;

2. there is an increase in the thickness of the renewal bark above the tapping cuts in the Sunderland system plots of 17.3 per cent, but a loss in the rate of renewal below the tapping cuts of 16.3 per cent.;

3. there is an increase in the rate of renewal in the double-four plots of 27 per cent above the tapping cuts, and a loss in the rate of renewal below the tapping cuts of 16.3 per cent;

4. the resting periods in the Sunderland system plots do not appear to have had any beneficial effects on bark renewal during the first three years. The increase in bark thickness above the cuts

is lower than that in the double-four plots which had no rest, and the renewal below the cuts in the Sunderland plots is only equal to that of the double-four.

Kuala Lumpur,

3rd March, 1937

THE TREATMENT OF THE PRUNED SURFACE OF LARGE STOCKS OF BUDDINGS OF HEVEA BRASILIENSIS

BY

C. C. T. Sharp

In a previous paper(1) it has been shown that when buddings are made on large stocks, the surface exposed by the final pruning should be at an angle of not less than 45° from the horizontal. It was also shown that the standard, asphalt-kerosene mixture retarded the growth of the callus tissues over the pruned surface. It was suggested that the high temperatures reached on the black surface brought about this retardation of growth.

In this paper a description is given of an experiment set up in Block 20 of the R.R.I. Experiment Station to test five new treatments of the pruned surfaces or snags of the budded trees.

Treatments

The five treatments employed and the control were as follows :—

A. Asphalt-kerosene mixture in centre. The standard mixture of two parts of asphaltum and one part of kerosene was smeared over the centre of the pruned surface and a ring about one inch wide was left untreated outside the treated area.

B. Similar to A but the black surface of the mixture was white-washed and the whitewash renewed at intervals when necessary.

C. A mixture consisting of one part cattle dung and three parts clay with enough added water to make it into a thick paste was smeared over the surface to a depth of a quarter of an inch. To prevent the mixture from being washed off it was covered over with a rectangle of old rice bag or hessian cloth which was kept in position by tying the upper end to the scion.

D. The cut surface was covered with a paint made of zinc oxide and raw linseed oil in the proportion of five to four by weight.

E. The surface was covered with a rectangle of old rice bag or hessian cloth kept in position as in C above.

F. Control No treatment.

Lay-out of the Experiment and the Experimental Material

Block 20 consists of a rectangular block of 22 acres of light sandy soil with some peat at the northern end. This block was

planted in December 1929, 30 feet by 30 feet, and interplanted to 15 ft. by 15 ft. in November 1931.

In April 1933 the trees were budded with sixteen different clones in eight duoclone blocks. Twelve of these clones were used in this experiment.

The treatments were applied only to the original trees, which were three years and three months old at the time of budding.

The mean girth of the stocks at the time of budding was fifteen inches, and trees with a girth of less than eight inches were not included in this experiment.

Each of the six treatments was applied to five trees of each of the twelve clones, the trees for each treatment being selected at random. There are thus five trees of each clone, or sixty in all, to which each of the six treatments was given.

The snags were pruned off at a uniform angle of 45° and the treatments were applied in May 1934, thirteen months after budding

Rate of Healing of the Pruned Surface after the different Treatments

Measurements were taken at intervals to show the progress of the callus growth in the manner previously described. The results are set out in Table I and are shown graphically in Fig. 1

Figure I

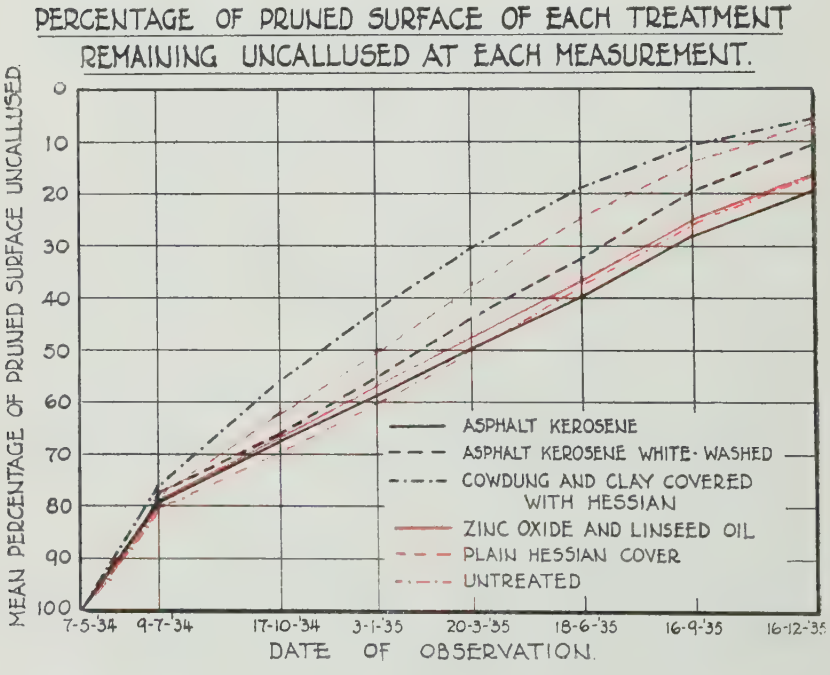


TABLE I

Percentage of the Pruned Surface remaining uncallused at each Measurement

Treatment	Date of measurement						
	9.7.34	17.10.34	3.1.35	20.3.35	18.6.35	16.9.35	16.12.35
A. Asphalt-Kerosene	79.3	67.4	58.6	49.9	39.9	28.3	19.8
B. Asphalt-Kerosene whitewashed	77.6	66.0	55.2	43.9	32.3	19.8	10.7
C. Cowdung and clay, with Hessian cloth	75.8	55.8	42.0	30.1	18.7	10.7	5.5
D. Zinc oxide and linseed oil	78.8	66.4	56.4	47.2	36.2	24.7	15.7
E. Hessian cloth	78.0	62.1	50.1	37.7	24.4	13.8	6.3
F. No treatment	80.9	69.5	60.1	50.0	37.2	25.6	15.9
Mean	78.4	64.5	53.7	43.1	31.4	20.5	12.3
Significant Difference			5.2		6.4		

The error of the experiment was calculated from the measurements taken on 1st January and 18th June, 1935.
Difference of less than 5.2 and 6.4 on those dates respectively may be due to chance and cannot therefore be regarded as significant.

Discussion

The biggest single factor in promoting the growth of callus appears to be the covering of hessian cloth in treatments C and E. Both these treatments are significantly better than the others tried. The addition of the cowdung and clay mixture is a further advantage and treatment C is the best of the six treatments under test.

The asphalt-kerosene treatment A, even when applied only to the centres of the pruned surface still causes a retardation of growth, but it is apparent that this retardation does not occur until the callus has covered the untreated part of the pruned surface and come in contact with the black surface. When whitewashed (treatment B) part of the heat which would otherwise be absorbed by the black surface is reflected, and growth is considerably improved.

Treatment D, zinc oxide and linseed oil, has no apparent effect, beneficial or otherwise.

The Effect of the different Clones on the Rate of Healing of the Pruned Surface of the Stocks

In Table II the amount of the snag surface remaining uncallused is shown for each clone irrespective of the treatment given to the pruned surfaces.

The lay-out of the experiment does not permit of any valid estimate of the error in this case, nor can it be said with certainty what proportion of the differences observed is due to clonal differences, and what proportion to the possible variations in the soil. But, in the opinion of the writer, there can be little doubt that B.D. 5 and P.B. 180 show a slower rate of healing than the others under test, and these two clones should not therefore be used for budding on to large stocks.

Subsidiary Experiment—Comparison of the Effect of Pruning before and after Wintering

In addition to the trees treated in the manner described above, sixty trees (Treatment G), chosen at random from those not required in the main experiment, were pruned and treated with the cattle-dung clay mixture in February 1934, that is to say before wintering instead of after wintering.

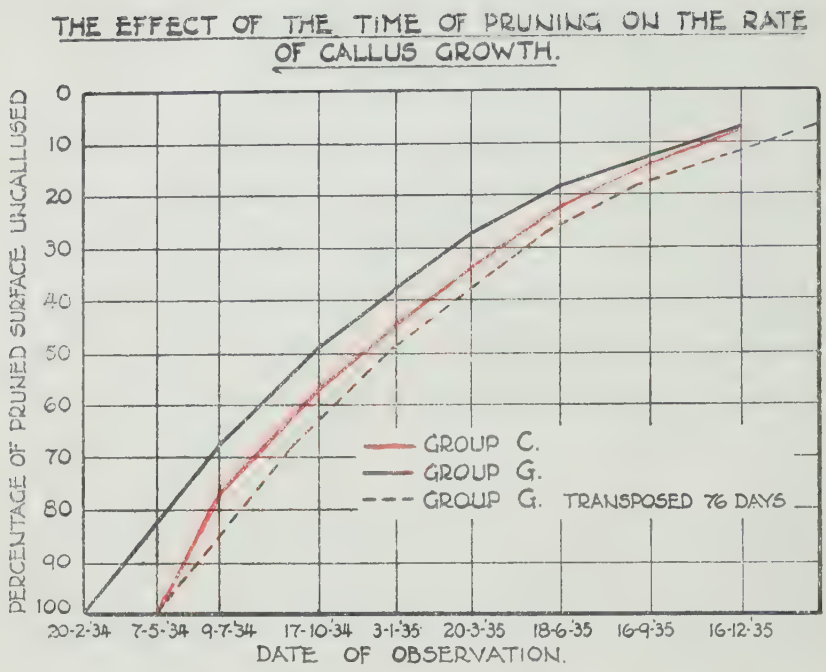
Of these sixty trees, thirty consisted of five trees each of six clones, namely A.V.R.O.S. 49, 256, B.D. 5, Lampongiana 1, Rubana 393 and P.B. 183. The rate of healing of these thirty trees is compared with the rate of healing of the thirty trees of the same clones in Treatment C. The results are shown graphically in Fig. 2.

TABLE II

Percentage of Pruned Surface remaining uncallused at each Measurement

Clone		Date of measurement						
		9.7.34	17.10.34	3.1.35	20.3.35	18.6.35	16.9.35	16.12.35
A.V.R.O.S.	49	78.1	61.2	49.7	36.2	27.6	17.5	10.0
Lampongiana	1	80.5	66.8	56.5	41.4	32.4	22.1	13.2
A.V.R.O.S.	256	76.9	61.7	50.0	38.2	25.8	16.7	9.1
Lampongiana	2	79.4	65.0	55.5	44.7	34.4	24.4	14.5
Bodjong Datar	5	78.5	65.1	58.4	52.9	42.7	31.3	20.3
Tjirandji	1	75.4	60.5	48.7	38.8	28.4	17.4	10.9
Prang Besar	180	79.0	67.5	57.1	48.7	38.3	27.6	20.7
Prang Besar	186	79.2	67.1	56.2	46.5	34.2	23.3	15.1
Prang Besar	183	77.0	61.7	51.6	42.8	27.3	15.3	8.1
Rubana	393	78.1	64.9	51.6	42.0	26.8	15.9	7.9
Waringiana	4	79.1	65.0	53.2	40.6	29.1	17.2	8.9
Sungei Reko	9	79.3	68.0	56.1	44.6	30.6	17.1	9.0

FIGURE 2



The red curve shows the rate of healing of the thirty trees of Treatment C.

The black, continuous curve shows the rate of healing of Group G on the actual dates on which the measurements were taken, and the black broken curve the rate of healing calculated to the same number of days after pruning as in Group C. The latter curve is therefore similar to the continuous curve but has been transposed by the equivalent of 76 days, the time that elapsed between treating Group G and treating Group C.

From examination of Fig. 2 it appears that the rate of healing is quicker if pruning is postponed until after wintering, but the difference is too small to be of practical importance.

Summary

Five different treatments of the pruned surface of large stocks of budded trees of *Hevea brasiliensis* were compared with a control (untreated). A paste consisting of one part cattle dung and three parts clay covered over with hessian cloth was found to be the most satisfactory.

The effect of budding the stocks with twelve different clones is compared.

It is found that postponing pruning the stocks until after wintering has very little effect on the rate of healing of the stocks.

Literature Cited

(1) Sharp C. C. T. *J.R.R.I.M.* **5** (1933-34) 152-159

3rd March, 1937

MANURING EXPERIMENT ON YOUNG RUBBER TREES

R.R.I. EXPERIMENT STATION—BLOCK 6

BY

C. G. Akhurst

The results given below relate to the manuring experiment in Block 6 at the R.R.I. Experiment Station, Sungei Buloh. Girth measurements and yields are recorded.* As this is the oldest and most carefully recorded experiment of its kind in the country full details of its planting history are also included.

Planting Material and Cultivation

Planting was done in October, 1928, after clearing and burning the jungle, using rubber stumps which had been grown from seed obtained from a high-yielding area. The area, which is quite flat, was bunded between plots, and creeping leguminous covers, *Calapogonium mucunoides* and *Vigna oligosperma,* were maintained on the bunds. Apart from these covers, clean-weeding was carried out, and at present, owing to the disappearance of covers caused by the overhead shade, the area is completely clean-weeded(1).

The soil is of a sandy quartzite type, uniform to 6 ft., at which depth a heavy white clay occurs(2).

Lay-out of the Experiment

The block, covering a 40-acre square, is laid out in the form of a 6 × 6 Latin Square, giving 36 plots. Each plot has 81 trees, and is separated from adjoining plots by single guard rows. Single boundary rows surround the whole experiment(3).

Manures

Five manuring treatments, together with an unmanured control, were put down, applications being made according to the schedule given in Table I. The earlier applications were made in circles around each tree, the size of the circle gradually increasing with the age of the tree, but at present fertilisers are broadcast between tree rows.

The six treatments are as follows :—Unmanured; cattle manure; "complete" inorganic manure; nitrogen only; nitrogen and phosphate; phosphate and potash.

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* *Earlier papers on growth measurements by Haines and Flint occur in this Journal* **2** *(1930) 31;* **3** *(1931) 94;* **4** *(1932) 123;* **5** *(1933) 78.*

TABLE I

Details of Manures applied in Block 6

(*Amounts applied per tree*)

Dressing	Date	Months after Planting	B. Plots	C. Plots	D. Plots	E. Plots	F. Plots	
			Cattle Manure	Inorganic: N.P.K.	Nitrogen: N.	Nitrogen + Phosphate: N.P.	Potash + Phosphate P.K.	
							Pot. Sulph.	Double Super
1st	October 1928	At planting	4½ lb.	Pot. Sulph. ⅜ oz. 20/20 Ammophos ⅜ oz.	Am. Sulph. ¾ oz.	Am. Sulph. ½ oz. Double Super ¼ oz.	½ oz.	¼ oz.
2nd	July 1929	9	6¾ lb.	Nitrophoska 2½ oz.	Am. Sulph. 1⅛ oz. Sod. Nitrate 1⅛ oz.	20/20 Ammophos 2¼ oz.	1⅛ oz.	1⅛ oz.
3rd	March 1930	17	20 lb.	Nitrophoska 12 oz.	Am. Sulph. 10 oz.	20/20 Ammophos 10 oz.	4 oz.	4 oz.
4th	September 1930	23	← as for 3rd application →					
5th	March 1931	29	← as for 3rd application →					
6th	October 1931	36	56 lb.	Enpekay No. I 2 lb.	Am. Sulph. 20 oz.	Nicifos B. 22 oz.	10 oz.	10 oz.
7th	December 1932	50	56 lb.	Enpekay No. I 2 lb.	Am. Sulph. 26 oz.	Nicifos B. 26 oz.	10 oz.	10 oz.
8th	January 1934	63	56 lb.	Enpekay No. I 2 lb.	Am. Sulph. 26 oz.	Nicifos B. 26 oz.	10 oz.	10 oz.
9th	February 1935	76	56 lb.	Enpekay No. I 2½ lb.	Am. Sulph. 2 lb.	Nicifos B. 2 lb.	14 oz.	14 oz.
10th	March 1936	89	56 lb.	Enpekay No. I 2½ lb.	Am. Sulph. 2 lb.	Nicifos B. 2 lb.	14 oz.	14 oz.

Note.—Am. Sulph. = Sulphate of ammonia; Pot. Sulph. = Sulphate of potash.

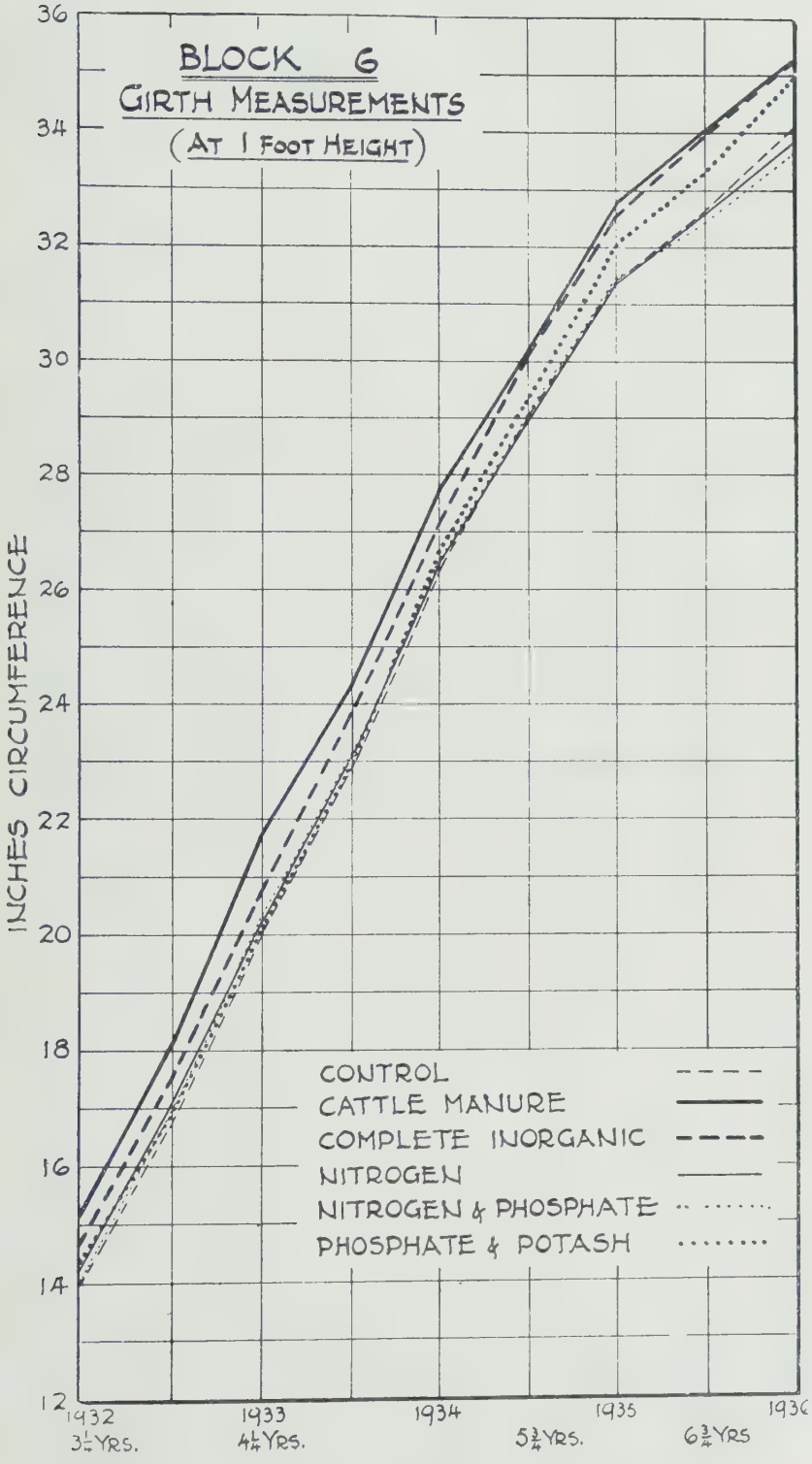
TABLE II

Girth measurements, in inches at 1 foot

Date of Measuring	Age of Trees in years	Girths						Successive increments over previous measurements.					
		A	B	C	D	E	F	A	B	C	D	E	F
								Control	Cattle Manure	Complete Inorganic N+P+K	N	N+P	P+K
January 1932 ...	3¼	13.99	15.16	14.65	14.21	14.06	14.34						
July 1932 ...	3¾	16.82	18.12	17.59	17.10	17.04	16.99	2.83	2.96	2.94	2.89	2.98	2.65
January 1933 ...	4¼	20.04	21.73	20.79	20.24	20.32	20.18	3.22	3.61	3.20	3.14	3.28	3.19
July 1933 ...	4¾	22.96	24.36	23.85	23.09	23.14	23.06	2.92	2.63	3.06	2.85	2.82	2.88
January 1934 ...	5¼	26.37	27.78	27.21	26.42	26.54	26.67	3.41	3.42	3.36	3.33	3.40	3.61
July 1934 ...	5¾	29.03	30.23	30.14	28.97	29.06	29.36	2.66	2.45	2.93	2.55	2.52	2.69
January 1935 ...	6¼	31.44	32.79	32.55	31.42	31.46	32.06	2.41	2.56	2.41	2.45	2.40	2.70
July 1935 ...	6¾	32.68	34.03	33.94	32.66	32.46	33.33	1.24	1.24	1.39	1.24	1.00	1.27
January 1936 ...	7¼	34.11	35.30	35.29	33.84	33.62	34.94	1.43	1.27	1.35	1.18	1.16	1.61

The above data are the mean tree girths for 6 plots of each treatment

FIGURE 1


BLOCK 6
GIRTH MEASUREMENTS
(AT 1 FOOT HEIGHT)
INCHES CIRCUMFERENCE
36
34
32
30
28
26
24
22
20
18
16
14
12
CONTROL
CATTLE MANURE
COMPLETE INORGANIC
NITROGEN
NITROGEN & PHOSPHATE
PHOSPHATE & POTASH
1932
3¼ YRS.
1933
4¼ YRS.
1934
1935
5¾ YRS.
6¾ YRS

Girth Measurements

Measurements are recorded at six-monthly intervals and are given in Table II. The earlier measurements showed that trees receiving cattle manure were growing slightly better than the others, but that differences among the different treatments were not very large.

The girth-growth curves approximate very closely to straight lines, and the slight irregularities are indicative of the higher growth-rate during the latter half of each year. (Figure 1).

Amongst other points brought out by these graphs, the parallel nature of the curves until the fifth year is clearly indicated (Figure 1), but subsequently the complete inorganic curve has converged upon, and now coincides with, the cattle-manure curve. Further, an appreciable flattening of the curves (*i.e.* decrease in growth-rate) has occurred in the last two years. This coincides with the period since the commencement of tapping.

The phosphate + potash curve is now approaching the cattle-manure and the complete-inorganic curves, and plants receiving this treatment appear to be maintaining their growth-rate better than the other plants.

A statistical analysis of the girth measurements shows that trees receiving cattle manure and complete inorganic manure are significantly larger than any others, with the exception of those receiving phosphates + potash. The latter are the next largest in size, and whilst significantly larger than trees manured with nitrogen alone and with nitrogen + phosphates, they are not quite significantly greater in size than the unmanured. (Tables III and IV).

Analysis of Data

TABLE III

Total Treatment Girths in inches

	A	B	C	D	E	F
	No Manure	Cattle Manure	Complete Inorganic	Nitrogen	Nitrogen + Phosphates	Phosphate + Potash
Totals for six plots	204.6	211.8	211.8	203.0	201.8	209.6

The above data are the sums of the mean tree girths for the 81 trees in each of the six plots of each treatment.

TABLE IV

Analysis of Variance

	Degrees of Freedom	Sums of Squares	Variance	½ $\log_e$	Calc'd Z	Obs'd Z (P=0.05)
Columns ...	5	5.53	1.106	1.20156	0.23725	
Rows ...	5	9.87	1.974	1.49134	0.52703	0.4986
Treatments ...	5	16.93	3.386	1.76114	0.79683	
Error ...	20	13.76	0.688	0.96431		
Total ...	35	46.09				

General Mean tree girth = *34.5 inches*
Standard Error = *0.985 per cent.*
Differences between treatment totals (Table III) which are greater than 6.0 are significant.

An analysis was also made using tree girths which were the means of the measurements from only 49 trees (instead of 81, as above); the measurements from the outside trees of each plot were omitted, only the 7 × 7 trees inside these being taken into reckoning. This means in effect that an extra guard row was allowed on each side of the original line of guard rows. Contrary to expectations, this method of treatment of the results did not lead to any greater accuracy. (Tables V and VI).

Analysis of Data

TABLE V

Total Treatment Girths in inches

	A	B	C	D	E	F
	No Manure	Cattle Manure	Complete Inorganic	Nitrogen	Nitrogen + Phosphates	Phosphate + Potash
Totals for six plots	205.4	212.0	211.4	204.1	202.0	208.7

The above data are the sums of the mean tree girths for the innermost 49 trees of each of the six plots of each treatment.

TABLE VI

Analysis of Variance

	Degrees of Freedom	Sums of Squares	Variance	$\frac{1}{2}\log_e$	Calc'd Z	Obs'd Z (P=0.05)
Colums ...	5	8.61	1.722	1.42303	0.31452	
Rows ...	5	14.47	2.894	1.68263	0.57412	0.4986
Treatments ...	5	13.80	2.760	1.65891	0.55040	
Error ...	20	18.37	0.918	1.10851		
Total ...	35	55.25				

General Mean tree girth = *34.54 inches*
Standard Error = *1.13 per cent.*

Differences between treatment totals (Table V) which are greater than 7.0 are significant.

It was anticipated that by utilising three rows as guard rows, any "stealing effect" on the manures of one plot by the trees of the adjoining plots would have been eliminated. Apparently, whilst this edge effect was no doubt eliminated, it was too small to outweigh the loss in accuracy resulting from such a large reduction in the number of trees which were measured.

Yield Records

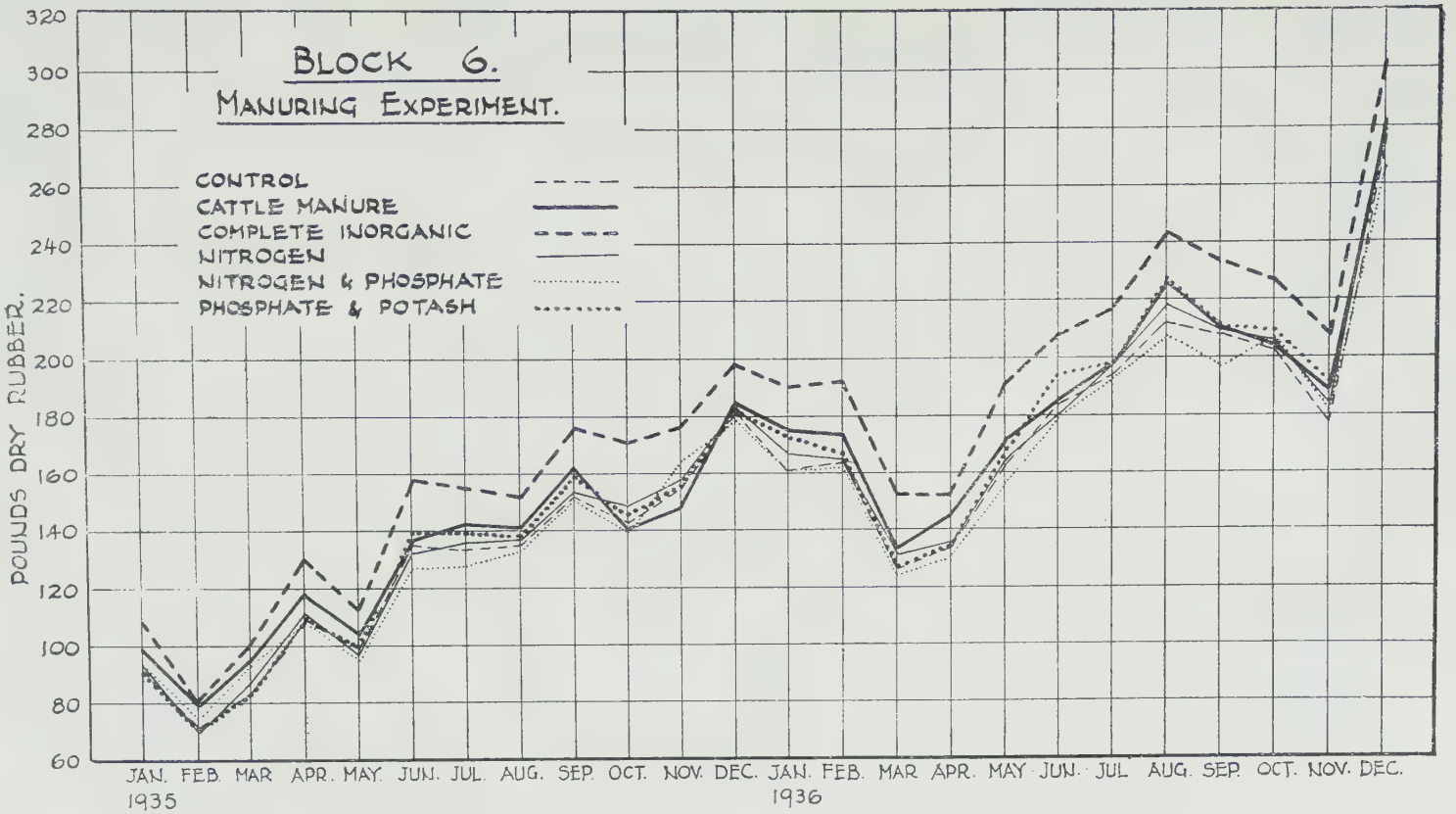
Tapping was commenced in January, 1935, the trees being just over six years old, and two years' records are here presented. Boundary rows and guard rows were not included; each plot was tapped alternate-daily, in two halves, one on a half-spiral cut and the other on a half-circumference V-cut.

Total yields for each treatment are shown for each month of the first two years in Figure 2.

The graphs bring out very clearly the consistently higher yield which has been obtained from the plots receiving complete inorganic manure, and also the fact that the yields are grouped comparatively closely together.

Apart from the fall in yield in dry weather (February and March), the minor month-to-month fluctuations of the curves have no real meaning, since on wet days the crop often has to be bulked and no individual plot yields are recorded.

FIGURE 2


BLOCK 6.
MANURING EXPERIMENT.
CONTROL
CATTLE MANURE
COMPLETE INORGANIC
NITROGEN
NITROGEN & PHOSPHATE
PHOSPHATE & POTASH
POUNDS DRY RUBBER.
320
300
280
260
240
220
200
180
160
140
120
100
80
60
JAN. FEB. MAR APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR APR. MAY JUN. JUL AUG. SEP. OCT. NOV. DEC.
1935
1936

Statistical analyses of the yields for each year bring out the same effect, namely that the trees receiving the complete inorganic fertiliser are yielding significantly better than those under any other treatment, and none of the other treatments has had any significant effect on yield, when compared with the unmanured plots. (Tables VII, VIII, IX, and X).

Analysis of Data

TABLE VII

Total Treatment Yields, 1935 (12 months)

(in lb. dry rubber)

	A	B	C	D	E	F
	No Manure	Cattle Manure	Complete Inorganic	Nitrogen	Nitrogen + Phosphates	Phosphate + Potash
Totals for six plots	1,494	1,556	1,721	1,507	1,487	1,516

TABLE VIII

Analysis of Variance

	Degrees of Freedom	Sums of Squares	Variance	$\frac{1}{2}\log_e$	Calc'd Z	Obs'd Z (P=0.05)
Columns ...	5	1,989	398	0.69064		
Rows ...	5	4,721	944	1.12248	0.48901	0.4986
Treatments ...	5	6,555	1,311	1.28668	0.65321	
Error ...	20	7,093	355	0.63347		
Total ...	35					

General Mean yield per plot = *258 lb.*

Standard Error = *2.97 per cent.*

Differences between treatment totals (Table VII) which are greater than 136 are significant.

TABLE IX

Total Treatment Yields, 1936 (12 months)

(in lb. dry rubber)

	A	B	C	D	E	F
	No Manure	Cattle Manure	Complete Inorganic	Nitrogen	Nitrogen + Phosphates	Phosphate + Potash
Totals for six plots	2,209	2,294	2,517	2,239	2,166	2,275

TABLE X

Analysis of Variance

	Degrees of Freedom	Sums of Squares	Variance	$\frac{1}{2}\log_e$	Calc'd Z	Obs'd Z (P=0.05)
Columns ...	5	3,667	733	3.29859	0.19934	
Rows ...	5	4,139	828	3.35952	0.26027	0.4986
Treatments ...	5	12,674	2,535	3.91899	0.81974	
Error ...	20	9,835	492	3.09925		
Total ...	35	30,315				

General mean yield per plot = *381 lb.*

Standard Error = *2.37 per cent.*

Differences between treatment totals (Table IX) which are greater than 160 are significant.

Bark Renewal Measurements

Measurements of bark thickness were made using a Lindeteves gauge, and these included thickness of the virgin bark (after lightly scraping away any loose corky material), and of the renewed bark at 22 months and at 12 months after tapping.

These measurements were examined, including comparisons of ratios of renewed bark thickness to virgin bark thickness, under

different manuring treatments, but there are no perceptible differences in the thickness of the virgin bark under the different treatments nor in the rate of renewal. (Tables XI, XII, XIII, and XIV). The average thickness of the virgin bark at the age of 8 years was 10.78 mms.

Analysis of Data

TABLE XI

Total Treatment Bark-thickness measured in mm., after 22 months' renewal

	A	B	C	D	E	F
	No Manure	Cattle Manure	Complete Inorganic	Nitrogen	Nitrogen + Phosphates	Phospates + Potash
Totals for six plots	50.46	51.89	49.07	48.34	49.64	52.09

The above data are the sums of the mean bark thickness per plot for each of the six plots of each treatment.

TABLE XII

Analysis of Variance

	Degrees of Freedom	Sums of Squares	Variance
Columns	5	1.70	0.34
Rows	5	12.46	2.49
Treatments	5	1.93	0.39
Error	20	9.47	0.47
Total	35	25.56	

General mean bark thickness (22 months renewal) = *8.37 mm.*
Standard Error = *3.33 per cent.*

Treatment differences are not significant.

TABLE XIII

Total Treatment Bark-thickness measured in mm., after 12 months' renewal

	A	B	C	D	E	F
	No Manure	Cattle Manure	Complete Inorganic	Nitrogen	Nitrogen + Phosphates	Phosphate + Potash
Totals for six plots	47.62	48.64	46.22	45.06	46.73	48.57

The above data are the sums of the mean bark thickness per plot for each of the six plots of each treatment.

TABLE XIV

Analysis of Variance

	Degrees of Freedom	Sums of Squares	Variance
Columns	5	1.12	0.224
Rows	5	14.05	2.81
Treatments	5	1.64	0.328
Error	20	8.98	0.499
Total	35	25.79	

General mean bark thickness (12 months renewal) = *7.86 mm.*
Standard error = *3.48 per cent.*
Treatment differences are not significant.

It is possible that in time the different manuring treatments will be reflected in variation in rate of bark renewal, although so far there is no indication thereof.

Discussion of Results

Fertiliser Balance

The extra yield obtained from the plots manured with the complete inorganic fertilizer can be ascribed to the presence of potash with nitrogen and phosphate, and this suggestion that potash is of

particular value is confirmed from several other blocks of rubber at the Experiment Station, where a peculiar yellowing and bronzing of the foliage which is occurring can also be attributed to potash deficiency.

The local cattle manure, which is rather deficient in both potash and phosphate, and also the phosphate + potash treatment have not improved the yield appreciably. This is a strong indication that correct balance in the composition of a fertiliser, when applied to young rubber, is essential for maximum latex production. Thus, in this particular experiment, on an admittedly potash-deficient soil, whereas nitrogen alone, nitrogen + phosphate, and phosphate + potash have had no appreciable effect, a considerable benefit has resulted from the use of all three elements together (complete inorganic fertiliser with a preponderance of potash). Thus it appears that on this soil nitrogen and potash are both limiting factors for latex production, neither producing a beneficial effect in the absence of the other. It is impossible to determine from this experiment whether phosphate has played any part in the total effect produced by the complete inorganic fertilizer. Such information could have been obtained if a treatment using nitrogen and potash had been included in the experiment, for then a comparison of the result obtained therewith, with that given by the complete (N.P.K.), would have indicated whether the omission of phosphate had any adverse effect.

In an earlier summary([4]) on growth measurements the comment was made that where nitrogen and phosphate were applied a lower rate of girth increase had been recorded (not significant) and now there is a similar deficit (not significant) in the yield from these same plots. No weight can be given to this difference since it is not statistically significant, but it suggests the possibility that on this sandy quartzite soil the presence of phosphate, without potash, may tend adversely to affect the nutritional balance of the trees.

Relation between Girth and Yield

When the girth measurements and yield records are considered together the outstanding feature is that the girth measurements afford no indication whatever of the increase in yield resulting from the use of the complete inorganic fertiliser.

Earlier girth measurements showed an advantage from the use of cattle manure, whilst the most recent ones indicate that this manure and the complete inorganic fertiliser are slightly better than most of the others, in their effect on girth. There is thus no indication from these girth measurements that, when tapped, trees manured with nitrogen, phosphorus and potash would yield 10% to 15%

better than any other treatment, including the organic manure treatment.

One must conclude therefore that, although the trees have been growing approximately at their maximum rate on the natural fertility of the jungle soil, the additional nutrients supplied by the added fertilisers, although unable to increase appreciably the trees' rate of growth, have none the less been able to affect the latex-production of the trees.

This conclusion, therefore, dictates caution in the use of girth measurements for estimating the effects of fertilisers on young seedling rubber trees. Large girth increases will still be considered reliable evidence of the benefit of a particular fertiliser, especially when the increases obtained without its use are sub-normal, but small girth differences, or the absence of differences, where two fertilisers are being compared, cannot safely be relied on as evidence of differences in or similarity of effect on yield. Only actual tapping records are reliable measures of the effect of treatments on yields.

Planting Material

In passing, it is of interest to compare the average girth from the unmanured plots (28.6", measured at 36 inches height) with that of trees in Block 9 (29.2", measured at 36 inches height). In Block 9, basket plants were used and were planted two months later than the stumps in Block 6, the planting distance and subsequent treatment being the same. In this instance, therefore, the stumps have made no better growth than the later-planted basket plants.

Cost of Manuring

Considering the cost of the fertilisers used and the value of the return by way of increased yield, no fair comparison can be made in the instance under consideration, because the original treatments were planned as a permanent manuring experiment and were not necessarily intended to be on an economic basis. For instance, the dressings of fertilisers are applied annually, but in average estate practice less frequent applications would have been made.

The total cost of all the dressings of the complete inorganic manure including the cost of application, is about $65/- per acre. The increased yield over the unmanured plots amounts to 102 lb. per acre (6 plots are reckoned at 5.22 acres), and on the basis of 20 cents per lb. being clear profit, this extra value is only $20/- per acre.

This is no fair indication of the possible economic benefits of suitable manuring of young rubber trees on such a soil, let alone on other and different soils, not only because the applications may be too frequent or too heavy but also because the proved need for potash

does not necessarily imply that it is needed so often or for so long as nitrogen. It is quite possible that if the original deficiency of potash were rectified by a heavy initial dressing, all that would be needed would be a lighter dressing at intervals of several years to maintain the supply at an adequate level, with more frequent dressings of the more fugitive nitrogen. Potash is retained relatively firmly in the soil, not being readily leached out, whereas nitrogen, if not taken up by the plant, is soon lost both by leaching and into the air. Moreover, in the absence of any indication of benefit from phosphate, it is possible that equally good results could be obtained, at less cost, by the use of a fertilizer supplying only nitrogen and potash.

Although the earlier results promised to show an advantage in favour of the organic manure in comparison with the inorganic fertilizer, this promise has not been fulfilled by the later results. However, this experiment cannot properly be used either for or against properly constituted organic manures as contrasted with inorganic, for, with the proved potash-deficiency of this soil, the comparison of the organic with the inorganic treatment is vitiated by the fact that the cattle manure used for the former is very poorly supplied with potash and possibly unable sufficiently to satisfy the requirements of the trees in that respect.

There are thus a number of manurial problems of considerable practical importance which this experiment leaves unanswered. This is no fault of the experiment, for a pioneering experiment of this kind must necessarily, if it is not to become impracticably cumbersome, confine itself to obtaining basic information as to the qualitative nutrient requirements of the crop on the soil in question—information which this experiment is supplying—and it is inevitable that the results of such an experiment will throw up further questions of practical importance. Such is indeed one of the justifications for an experiment of this kind, and this experiment is fully justified in that respect also. Finally, it must be remembered that the results which have been presented and discussed refer to young seedling rubber trees and to one soil-type, and in attempting to make general application of the conclusions which are drawn, these two factors must not be overlooked. Soils similar to this, though of poor quality and lower fertility, have been described by Hamilton([5]).

Comparison of Half-Spiral with V-tapping cut

As mentioned above, half of each plot was tapped with a half-spiral cut, and half with a V-cut, each being half-circumference in width. As a subsidiary and independent aspect of the experiment, the yields obtained with these two tapping systems may be compared.

TABLE XV

Yield Figures, 1935

Total Yields

	Jany.	Feby.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Lb. Rubber	577	446	542	688	609	832	837	838	954	888	959	1,111
Wts. of rubber from bulked latex	=				+ 29	+ 10		+ 47		+ 55	+ 46	+ 42

Grand Total = 9,510

Single Cut (Half-spiral)

Lb. Rubber	300	232	286	360	312	429	428	427	487	449	483	563

Double Cut (V-cut)

Lb. Rubber	276	214	256	328	296	404	409	411	467	439	476	548

Ratio : $\frac{\text{Double}}{\text{Single}}$

	0.920	0.922	0.897	0.911	0.947	0.941	0.955	0.962	0.962	0.979	0.986	0.974

Total Yield from Single cut = 4,756

„ „ „ Double cut = 4,524

TABLE XVI

Total Yields — *Yield Figures 1936*

	Jany.	Feby.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Lb. Rubber	1,078	1,024	806	850	1,014	1,130	1,198	1,334	1,270	1,256	1,131	1,686
Wts. of rubber from bulked latex =					+ 68	+ 26	+ 75	+ 36	+ 120	+ 120	+ 68	+ 56

Grand Total = 14,346

Single Cut (Half-spiral)

Lb. Rubber	513	514	402	418	507	570	601	666	641	626	565	845

Double Cut (V-cut)

Lb. Rubber	516	510	396	415	508	560	597	668	629	630	566	841

Ratio : $\frac{\text{Double}}{\text{Single}}$

	1.006	0.992	0.985	0.993	1.002	0.982	0.993	1.003	0.981	1.006	1.002	0.995

Total Yield from Single cut = *6,868*
„ „ „ *Double cut* = *6,836*

It will be seen from the data above (Tables XV and XVI) that during the first twelve months of tapping the half-spiral cut gave about 5 per cent higher yield than the V-cut, but in the second twelve months, there has only been a very small difference (less than 0.5 per cent) in yield between the two systems of tapping.

During the second year, the total yield has increased by 50 per cent over that obtained in the first year. (Tables XV and XVI).

Summary and Conclusions

(i) Measurements of girth, yield and bark thickness are presented relating to young seedling rubber trees, planted in virgin jungle soil (sandy quartzite type) which have been manured experimentally.

(ii) Cattle manure and complete inorganic manure have produced growth which, on girth measurements, is just significantly greater than that of trees which received no manure, nitrogen only, and nitrogen + phosphate.

Trees manured with phosphate + potash are just significantly larger than those receiving nitrogen alone, and nitrogen + phosphate.

(iii) Yield data for the first two years of tapping show that the complete inorganic fertiliser has produced a very significant increase over any other fertiliser, and is the only fertiliser which has affected the yields significantly.

(iv) Bark renewal has not yet been influenced by the fertiliser treatments.

(v) Girth measurements of young manured seedling rubber trees do not necessarily reflect their relative yielding capacity.

(vi) Correct balance of plant foods in a fertiliser, in relation to soil type, is important when the manuring of young rubber trees is being considered, and on soils similar to this sandy quartzite the value of potash manures in particular, used in conjunction with nitrogen, is emphasized.

(vii) In order that the amount of growth and the level of yield of the rubber trees in this experiment may be compared with similar information for other areas, the relevant data are summarised below, as averages for the whole area :—

Planting Material	Ordinary seedling stumps from a high-yielding area.
Age of trees	8 years and 2 months
Average girth at 1 foot	34.5 inches
Average girth at 3 feet	28.9 inches.

Yield per acre 1st year of tapping (6 yrs 2 mths to 7 yrs 2 mths) 303 lb.
Yield per acre 2nd year of tapping (7 yrs 2 mths to 8 yrs 2 mths) 458 lb.
Thickness of renewed bark, after 12 months renewal 7.86 mm.
Thickness of renewed bark, after 22 months renewal 8.37 mm.
Method of tapping. Alternate-daily ½ V-cut and ½ Spiral Cut.

(viii) A subsidiary aspect of the experiment was the comparison of yields obtained with half-spiral and V-cuts, each half-circumference in width. In the first year of tapping the half-spiral gave about 5 per cent higher yield, but in the second year the difference in yield between the two systems was less than one-half per cent.

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BOOK REVIEW

"Diseases and Pests of the Rubber Tree" BY ARNOLD SHARPLES

(Macmillan & Co., Ltd., London, price 25s.)

Up to the present time Petch's book has been regarded as the classical text-cum-reference book on Pests and Diseases of the Rubber Tree. It was with the idea of bringing the information in this book up to date and revising it in the light of modern knowledge that Mr. Sharples set about the great task of writing the book now under review. The book presented to us is a monument to the singular abilities and keen sense of duty of our late colleague, the author.

Though much of the more modern work recorded in this book is taken from reports and published work of the Pathological Division of the Rubber Research Institute he has also quoted generously from many contemporary workers both in Malaya, the Netherlands East Indies and other rubber-growing countries, though in this respect we would like to have seen more mention of the work of the late Messrs. Sanderson and Sutcliffe in the Research Laboratories of the Rubber Growers Association.

Considering the fact that the Pathologists now on the staff of the Institute were members of the Pathological Division during the time that Mr. Sharples was Head of that Division, it is no reflection on the author if parts of this review tend to be somewhat critical.

The book is divided into several parts as follows:—

PREFACE AND INTRODUCTION. An admirable though rather lengthy statement of the chief workers on the subject, and of the precedents and intentional repetitions one may find in the book.

PART I. This consists of general remarks on plant diseases, structure, reproduction and physiology of fungi covering some 45 pages with chapters on general relevant topics such as loss from diseases, plant disease work during the period 1931—1934, and the mycologist versus the plant pathologist. From the latter we gather that while the mycologist may be the better trained to deal with the science of fungi, it requires a plant pathologist to apply that science to commercial crops with a view to estimating not only the effect of plant parasites upon the crop but also that of environmental and nutritional factors.

A second chapter describes factors determining the cause of disease; a third contains good text-book information on the physiology of fungi; while a fourth describes the influence of external factors

on rubber-tree diseases. The last mentioned chapter, though very good, might have been improved by giving more specific diagnostic characters relating to rubber, and the effects upon the plants of methods of planting, opening up, tapping etc. There is a slip on p. 41 line 9, where the North West monsoon is referred to instead of the North East monsoon, which incidentally is also responsible for the rain in November to January as well as the fine dry weather of February and March.

Part II consists of two chapters covering 18 pages dealing with plant form and plant function respectively. These are excellent chapters and will serve both for the student and the planter. There are, however, one or two notable omissions. There is no mention of the lenticels or breathing pores on the roots and stems, nor of the water-pores or hydathodes of the leaf, though the stomata are described fully. We disagree with the author's statement on p. 69 that "No special mention of transpiration by the leaves or water absorption by the roots is necessary, as there are no phenomena concerned in these comparatively simple processes which demand explanation." Surely it is the impairment of these and of respiratory processes which is often the first-noticed symptom of disease? The external appearance of a healthy mature rubber root is not described or illustrated, yet surprisingly few scientists or planters know what a healthy rubber root really looks like.

Part III consists of a full description of the various diseases and pests of the tree of economic importance.

Section 1 of this part deals with root diseases. In this section the author discusses in Chapter VII, general matters in connection with root parasites among which is the systematic position of the fungi causing root parasites. His final settlement of the position and nomenclature of the various rubber root fungi in the mycological flora will find general acceptance in Malaya.

This is followed by an interesting discussion on the influence of cultural operations,—implemental and vegetative (cover crops),—insect parasites and chemicals on the incidence and spread of root diseases.

Chapter VII gives an excellent and well-illustrated description of the two root parasites which are regarded as of relatively minor importance in Malaya, viz. Collar and Stem rot caused by *Ustulina zonata* Lev. Saac. and the aromatic root disease of badly-drained areas *Sphaerostilbe repens*, B and Br. The major root parasites are discussed at length in Chapter IX and the author has, by his long experience of root diseases, been able to make good use of the results of much of the more recent experimental work carried out by the Rubber Research Institute both on estates and on the Institute's

Experiment Station. The author and his late colleague Mr. A. R. Sanderson published a previous R.R.I. bulletin on the "Root Disease Problem in Old Rubber," and many of the views expressed therein are again brought forward in this book.

In regard to the three root parasites *Fomes lignosus, Ganoderma pseudoferreum* and *Fomes noxius,* adequate descriptions of the fungi and their rhizomorph and surface skin formation are given but we would like to have seen a further diagnostic symptom, such as the distinctive type of wood rot produced by each fungus, described more fully in the text.

The probability of spread of infection is discussed and it is concluded that it is unlikely that such spread can take place by wind-borne spores to any great extent. In this connection the author does not mention the occurrence of *F. noxius* on the stems of oil palms where infection is carried by some agency such as vermin, or is wind-borne.

On p. 167 the author undermines his previously-expressed views that root diseases spread only by root contact, by stating in paragraph 2 that "The latter (*F. lignosus*) can spread independently through the soil from a jungle stump....." This is an unfortunate statement at this juncture and forms an unfair comparison with the spread of *F. lamoensis.* Again, much is written of the regeneration of roots from the exposed upper surfaces of large lateral roots, the extremities of which have been killed off by *Ganoderma pseudoferreum.* The true significance of this phenomenon is not stressed, and though exposure of the attacked root may be a primary cause of the stopping of progress of disease, it is a fact that owing to some natural influence, external or inherent in the fungus itself, an apparent resting stage occurs in the life of the fungus which becomes evident in the form of loss of virulence such that the tree is able to lay down a thick gum layer in the wood and to develop a vigorous callus from which roots bud out and grow healthily for many years until a further period of activity of the fungus occurs. These periods of rest and quiescence on the part of the fungus are not properly understood and the factors influencing them should form an important part in future research work on root diseases. Further it is this periodic rest on the part of this root parasite which has enabled large areas of old trees to remain standing to-day despite the pessimistic prophesies of earlier writers that root diseases would wipe out the majority of old rubber areas in Malaya in a few years.

Chapter X is a very readable discussion on the other root affections, on influence of rhizomorphic activity on cultural methods to be adopted in clearing of jungle, replanting of old rubber areas and control of the diseases under various agricultural conditions in Malaya.

The scare raised in other countries as a result of the discovery of the soil fungus *Rhizoctonia bataticola* has been well and justly laid by the author.

In regard to costs of replanting one of the budgets given by the author can hardly be regarded as typical. The planting of old building sites may be desirable, but it is misleading to quote such a thing as cost of breaking concrete floors etc. when budgeting for cost of replanting normal old rubber areas.

Section 2 of this Part deals with Tapping Panel Affections. In Chapter XI a long description is given of the occurrence of Mouldy Rot and the life history of its causal fungus, *Cerastomella fimbriata*. The investigations into its spread and methods of control are also adequately described, though we do not agree that the hyaline endospores are quite so easily destroyed as one is led to believe. It can be easily shown in the laboratory that the hyaline endoconidia are more resistant to the common tar acid emulsions than the brown macroconidia, though the reverse is true for desiccation.

The chapter on Brown Bast is good so far as it goes. The author omits a microscopic diagnosis of this disease as being unnecessary. Though he mentions the influence of tapping systems on the incidence of Brown Bast and quotes Sanderson and Sutcliffe as finding the presence of meristematic tissue near latex vessels in Brown Bast, no reference is made to Rhodes's paper on this subject in the *Journal* of the Rubber Research Institute (1930) nor to the Rubber Research Institute circular on the control of this disease. Thus this portion can be considered as somewhat out of date at the time of publication.

Chapter XII deals with the Phytophthoraceous fungi on the panel and stems of the rubber tree and forms a very good statement of our present knowledge on this subject. One must realise in Malaya that this group of fungi would assume a very much greater importance as the cause of Black Stripe, Patch Canker, leaf fall, Pod Rot and budshoot-dieback—which by the way *does* occur in Malaya—if a continuous long wet season were experienced.

It is stated on p. 247 that "the disease (of young bud shoots caused by *Phytophthora palmivora*) has not yet been reported from Malaya," after which is quoted Murray (Ceylon Rubber Research Scheme) who himself quotes Weir from the Annual Report of the Rubber Research Institute as describing a similar disease and mentioning a Phytophthora as a possible agent.

Chapter XIII on minor panel diseases is quite good and the descriptions of the new fungus species *Marasmius palmivorus*, though perhaps not strictly in place in a book like this, is very interesting to the scientific reader.

Then follows in Chapter XIV, constituting Section 3 on stem diseases, an excellent description of the occurrence, causal fungus and treatment of Pink Disease in Malaya. It might perhaps have been enlarged and improved by a discussion of the importance of Pink Disease in cover plants and in young rubber, especially now that shrub and bush covers are commonly planted as cover in young rubber areas. We would also like to emphasise that asphalts or tar mixtures must not be used on green stems, on which a water-miscible tar-oil fungicide must be used.

The part dealing with "*Diplodia*," though excellent in its way, may be liable to give a false sense of importance to what is now regarded as a fungus of less than secondary importance.

In this section the mention of *Loranthus* mistletoes is out of place. It would, in our opinion, have been better to have made a separate chapter for them together with other epiphytes such as mosses and lichens, which are not mentioned. The descriptions of the minor diseases of the stem are of a high standard.

Section 4 beginning with Chapter XV, describes fully the major and minor leaf diseases of Hevea. The full descriptions of the various individual diseases make good and interesting reading.

In regard to *Oidium Heveae* it would have been better, when discussing the climatological influences, to have described first the influence of the two monsoon periods on Malayan weather and on the "wintering" of Hevea; then to deal with the influence of temperature and humidity on the fungus itself and finally to show how with certain different coincidences of conditions the leaves may be retarded and the fungus aided in development, or *vice versa*. The influence of sunlight upon the rate of development of the new rubber foliage after wintering might have been emphasised more.

Regarding the diseases of leaves and pods of rubber trees caused by the Phytophthoraceous fungi some confusion seems to have arisen as to what species have been reported from Malaya. On p. 294 it is stated that *P. Meadii* has not yet been reported from Malaya. On p. 314 it is stated that Thompson (Malayan Department of Agriculture) found in addition to *P. faberi* and *P. meadii* two other species, *P. heveae* and a Pythium from naturally occurring Pod Rot in Malaya. Reports of abnormal leaf fall and Pod Rot have been received by the Rubber Research Institute for many years past and have on occasion been confirmed by cultures from specimens sent in for diagnosis. In some wet coastal districts the attacks—though local—have caused considerable alarm.

The control of *Phytophthora* diseases of this type by spraying would be impossible in Malaya, and the use of copper dusts would probably have to be resorted to in spite of the author's views on the dangers of using copper-containing fungicides.

Chapter XVI gives a lengthy description of the author's investigation on the occurrence of lightning damage among tree crops in this country, together with excerpts of reports by other investigators. The chapter might have been considerably improved by the incorporation of more precise diagnostic characteristics either of a macroscopical or microscopical nature, such as are available at the Rubber Research Institute.

On p. 338, the author recommends for treatment of trees damaged by leaf fires the application of a mixture containing 80 per cent. tar and 20 per cent. crude oil to the scorched bark after scraping off the charred tissues. This treatment surely is condemned by his own subsequent arguments. Leaf fires occur during hot dry wintering seasons and the author tells us on p. 349 that black surfaces, such as those coated with tar or asphalt, absorb heat rapidly and cause overheating and death of tissues below them, which one would expect merely to accentuate the damage caused by the heat of the leaf fire. This Institute recommends, after scraping off the charred tissues, the application of a weak mixture in water of one of the tar-acid fungicides used in control of Mouldy Rot. When dry, apply whitewash around the base of the tree and up the trunk as far as scorching has taken place.

On p. 338 *et seq*, sunscorch of surface roots and of the base of young seedlings is discussed and treatment suggested. The author fails to mention the abnormal development of cork bark on the upper surface of roots so exposed. Unfortunately the "Diplodia scare" is again given prominence.

In regard to sunscorch of seedlings the author might have drawn attention to the influence of seasonal climate on success of germination of seed, transplanting and nursery work generally, in an otherwise excellent article.

Chapter XVII. Under the heading "Miscellaneous" the author discusses several subjects which in our opinion would have been better placed under headings of other related chapters. Wound-healing, spotting of plantation rubber, the use of copper sprays (not entirely up-to-date), abnormalities, cover-crop relationships and "Bark Bursts" are among the more important matters here discussed.

Section 6, on Insect Pests, is a very useful section covering all types of insects of economic importance found on rubber. White Ants (*Termites*) and the Cockchafer grub (*Psilopholis grandis*) both receive the full treatment that their places among insect pests of rubber trees in Malaya warrant. It is unfortunate that the discovery of a new pest, "Thrips", was reported too late for inclusion in this book.

Chapter XIX, describes the damage caused by the higher mammals: Elephants, Deer, Pig, Goats, Rats, Squirrels; and also by Spiders and the Mollusca (slugs and snails). It is stated that there was no definite record of rat damage in Malaya until 1933. Actually rat damage has been a constant source of worry to young rubber plantations for many years, as recorded in the Rubber Research Institute Annual Reports of 1928 onwards.

In Chapter XX the author gives a fair description of the preparations used in plant protection. It could have been enlarged considerably by the inclusion of more spray mixtures such as lead arsenate, kerosene emulsions, liver of sulphur, derris and pyrethium sprays, commonly used to control insect pests in Malaya.

It is surprising that after explaining and defining the terms "disinfectant" and "fungicide" the author subsequently frequently uses the term "disinfectant" where the term "fungicide" would seem to be preferable, particularly in relation to Mouldy Rot control.

Chapter XXI. This chapter on Forestry Methods of Cultivation discusses and summarises the introduction of natural covers in place of clean-weeding, the reasons for the early success of natural covers on some areas, and the need subsequently for controlling the growth and types of natural covers from the point of view of soil improvement and minimising the incidence and spread of disease. Though the author states that a low-growing leguminous green cover would be preferable to a natural cover of mixed forest plants he offers no explanation of the reason why such covers have not been developed or why such legumes as are known do not thrive under shade. Is it due directly to shade, or to disease, or to unfavourable soil conditions or to a lack of some essential chemical factor in the soil? However, the author deals with the problem of root disease, panel diseases and regeneration of the rubber stand, under "forestry" conditions, in no uncertain manner. It is a chapter which should be of great interest to both planter and scientist.

Though the book as a whole contains no serious mistakes the following corrections are suggested:—

Preface p. IX line 29, Mr. Lim Keng Chuan should read Mr. Hoh Choo Chuan.

pp. 1, 206 etc. "Dr. J. H. Weir" should read Dr. J. R. Weir.

p. 41 line 9, "North West" should read "North East."

p. 218 line 16, "endospores" should read "conidiospores."

p. 219 line 20, "Frey-Wesselinghe" should read "Frey-Wyssling."

p. 290 line 36 and p. 291, under illustration, "*Loranthus pentrandus*" should read "*Loranthus pentandrus*."

p. 295 line 4, "Casual" should read "causal."

p. 350 line 6, "68°F" should read "36°F."

p. 436, in list under group *Peronosporaceae* and above *Phytophthora faberi* insert the species "*Phytophthora palmivora.*"

p. 467 in list, "*Fomes pseudoferreus*" should read "*Ganoderma pseudoferreum.*"

At the bottom of p. 467 add the species "*Fomes noxius.*"

The fungus *Oidium Heveae* is not listed in the appendix, and it is suggested that as this fungus will probably be proved to belong to the group *Erysiphaceae* it may be placed on p. 466 as the sole occupant of a group under this heading immediately above the group *Perisporiaceae.*

The faults of omission or commission to which attention has been called in this review are all comparatively unimportant, and it is a tribute to the excellence of the book that none but such minor blemishes should have called for comment. The book is indeed a masterly production which will be of the utmost value to planters and scientists alike; much of it will well repay study by the latter even though they are not primarily concerned with pests and diseases.

BOOK REVIEW

"The Study of the Soil in the Field" BY G. R. CLARKE

(Oxford, Clarendon Press, 1936)

The study of the soil in the field is as essential to the understanding and classification of soils as the laboratory investigations, but it is only comparatively recently that the importance of field work has been recognised.

The author is to be congratulated on the comprehensive and complete manner in which he has assembled all aspects of his subject under the chapter headings: The Soil-Profile Pit (soil-profile description); Soil-Sample Collection (monolith collection); Mapping of Soils; Notes of Various Soil-Survey Systems. Over one-third of the book is devoted to the soil-profile pit and soil-profile descriptions, which are dealt with exhaustively.

The necessity of utilising the soil-profile pit in soil survey work is emphasized throughout the book, and, whilst the author's experience presumably is limited to field studies in temperate climates, his remarks are applicable to tropical soils. The page and a half devoted to tropical soils merely serves to concentrate attention on the sparseness of our knowledge of them and on the vast field of work which awaits soil scientists in the tropics.

Soil studies in Malaya are simplified to some extent by the detailed geological studies and maps which have been made and also by the comparative simplicity of the soil-profiles. Deeply weathered and uniform profiles, lacking any pronounced zoning, are characteristic of soil profiles in this country.

The author's intimate knowledge of his subject is clearly indicated by the many points of practical detail which he mentions. One feels bound to disagree, however, with two of his recommendations, in so far as they apply to Malayan conditions, namely, that 'taste' is a useful additional test to that of 'feel', and that though "the work may be hard and tedious—the observer should himself dig as much as possible" of the pit, in order to obtain much valuable information by the feel and sound of implements during digging operations! The physical disadvantages involved in following this advice in the Malayan climate, and the length of time involved, are out of all proportion to the value of the information obtained.

The book can be confidently recommended to soil scientists in general and to all engaged in soil field work.

C. G. A.

REPLANTING

CHOICE OF CLONES FOR REPLANTED AREAS

The following circular, which has been issued from the Botanical and Soils Divisions is reprinted for general information :—

A large number of enquiries have been received at the Institute recently on the subject of the choice of clones for use in replanted areas. Very frequently the enquiry is accompanied by a list of clones available on the estate, but no information is given in regard to the type of land and other general conditions under which replanting is being undertaken.

We have collected a considerable amount of valuable information during recent years on the growth, development and, in some cases, on the yield, of different clones on different soil types, so that it is now possible to select clones that are likely to prove most satisfactory for particular situations.

It is therefore requested that enquiries on the subject of choice of clones should be accompanied by the following information.

1. General brief description of the area; lie of land etc. Notes on the quality of the rubber trees cut out; age, growth, condition of foliage and bark, previous yields. Notes on history of previous cultivation.

2. Soil profile pits should be dug in representative parts of the area. Pits should be 6 feet deep × 3 feet square and one side of the pit should be kept free of excavated soil.

3. Descriptions of the soil profiles should be given on the following lines :

   (*a*) Position of pit, *i.e.* top, side or bottom of hill.

   (*b*) Colour of soil with changes at different levels and the depths at which changes occur.

   (*c*) Depth of organic colouring (" Humus ") of surface soil.

   (*d*) Notes on texture and compactness of soil at different levels.

   (*e*) Presence of stones, laterite (shape and size of lateritic masses is of interest), quartz fragments or other types of stones.

   (*f*) Depth of water-table if visible.

4. Average rainfall for the district should be given. The occurrence of heavy storms likely to result in damage to trees should also be noted particularly if the area is in an exposed situation.

5. If young budded areas have been established on other parts of the estate on soil of similar type to that in the replanted area, notes on the appearance and vigour of different clones will be of great interest and value.

C. E. T. MANN

Senior Botanist

C. G. AKHURST

Senior Soils Chemist

Kuala Lumpur,
29th July, 1937.

SAMPLES AND SPECIMENS

FORWARDED BY ESTATES FOR EXAMINATION

Samples and specimens forwarded to the Rubber Research Institute for examination and/or analysis should be clearly marked with labels bearing the name of the estate of origin and the reference number of the covering letter in which the samples or specimens are listed and in which the reasons for sending them are given.

It would be of considerable assistance if a *copy* of the covering letter could be packed within the parcel containing the samples. This applies equally to specimens of plants, and of diseases and pests, for identification; to seeds from budded trees for confirmation of identity of clones; to samples of soils or fertilisers; and to samples of raw rubber or other materials. Many parcels of samples or specimens often arrive by the same post, and by a different delivery from that of the related correspondence; it is sometimes a matter of great difficulty to ascertain the sender of the parcel.

THE RUBBER RESEARCH INSTITUTE OF MALAYA

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October 1937

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Edited by H. J. Page on behalf of the Board of the Rubber Research Institute of Malaya.